Healthcare system using succulent parts of plants

Volume II : Steps for production and marketing of selected healthcare products

Dr. Shibabrata Pattanayak

HEALTHCARE SYSTEM USING SUCCULENT PARTS OF PLANTS

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selected healthcare products

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Dedicated to:

The research workers who hate to trust that

the stereotyped ideas should control all

research planning

PREFACE

This second volume of the book is written to initiate marketing of a few bio-medicines, a few skin care and hair care products and some unaltered fruit juices, fruit pulps and fruit ice-creams as an alternative of available products of similar category added with many toxic chemicals. It may be considered as an initiative to bring such products in the market for the first time. All the related researchers, policy makers, entrepreneurs and the persons feel interest in such products are invited to contribute their efforts in this venture.

As these medicines and healthcare products have the capability to reduce the market of chemical-based medicines and chemical added products, the manufacturers and entrepreneurs of those fields may obstruct the path of introduction of this system. But I am sure; such products will come in the market as it is the demand of the present time. This novel system may be brought into reality very soon if pressure from the people of different sections of the society is added with it.

The book is given heading as "Steps for production and marketing of some selected healthcare products", but in another sense, this volume of the book is complementary to the first volume. The subjects described in volume one of the book are not described in volume two, only the related portions are referred. Some treatment schedules are also proposed which may serve as a model to start research in these aspects. During description of contemporary systems, some complete sections are taken from some articles to add in this book. These articles are referred. However, for better understanding of these sections, original articles may be consulted.

I expect involvement of all sincere readers of this book in initiation and spread of the concept and use of that novel type of food products, medicines and natural cosmetics. If such efforts are added, all of our global neighbors will get these products for their own health benefits very soon.

Date: 11.11.2019

Thanking you,

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HEALTHCARE SYSTEM USING SUCCULENT PARTS OF PLANTS

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Content

Chapter 1

Healthcare products from succulent plant parts: a novel idea for field implementation

Succulent parts of different plants may be used in many purposes for their versatile efficacy. The fruit, leaf, root, stem, flower etc. parts may be used as oral medicines, in skin and hair protection as well as other cosmetic purposes, and definitely as some unaltered, chemical free fruit juices, fruit pulps or fruit ice-creams. Uncontaminated preparation, proper packaging and transportation up to the consumer level are some very most important areas in the whole process.

Change of wrong lifestyle and follow of well directed lifestyle may be considered as a part of medication through medicines of natural sources. In fact, it is practically desirable in all types of treatment. The overall dos and don'ts are very much important for desirable action of treatments, restoration of health and staying disease free. Some specific requirements definitely are there for specific conditions and/or treatments.

Healthcare by use of succulent bio-medicines may be performed by a single medicine or through use of combination of more than one medicine as per the specific requirements. Selection of proper medicine/s, dose of medicines, period of treatment etc. should be determined after proper research. Many of these sections are discussed in the Volume I of the book.

The proposed products are termed as Bio-medicines or Bio-products to distinguish them from all other products added somehow with any material of non-biological synthetic origin.

In this volume, preparation of some important bio-products with possible positive effects on health is discussed. These include collection, packaging, storage, transportation, sale and use of pulp and/ or juices of some very useful fruits without using and adding any synthetic chemical at any name or form at any stage. The same or alike steps are discussed for the preparation as well as use at the consumer's level of some truly non-toxic and time-tested skin care and hair care products.

Some sections are added with description of available tools to identify the effective ways and means for preparation, marketing and use of healthcare medicines of that novel type in this volume. These may also assist in marketing-oriented research on other succulent bio-medicines as proposed in Volume 1 of this book.

A model to perform detail research to prepare specific guidelines and treatment schedule for different types of diseases by the use of succulent bio- medicines is also added at a tabular form. In all of these sections, traditional practices acted as some basis for the research and preparation of proposed indications.

Chapter II

Guideline for production of succulent bio-medicines and other healthcare products

Collection of materials

The plant materials may be collected by hands covered by sterile gloves or by use of any mechanical mean. Then the materials should be washed by germ free water and then distilled water. Fruits and vegetables may be soaked in salt, vinegar, and lemon juice for 20 minutes prior to preservation [1].

A wash by 70% Ethyl alcohol may be added to control the vegetative micro organisms of the surface of the plant parts.

The surface of the fruit, leaves etc. may require mechanical removal of added dusts and other materials. Sterile absorbable cotton soaked with 70% Ethyl alcohol may be used for that purpose. Potassium permanganate, Alum, Sodium bicarbonate, Lime water etc. chemicals may be used for such primary washing as per specific requirements.

After such washing, a final thorough washing by distilled water (of normal room temperature, lukewarm temperature or hot water as per the requirement) may be required.

Then the materials may be kept under shade with flow of dust free and germ-free air (as performed in laminar flow system) for removal of added water droplets.

Production of cut pieces, pastes and juices of succulent plant parts

The external cover of the cleaned plant parts (of fruits, roots, stems etc.) may be removed by proper sterile sharp instruments. The materials may be divided into some pieces by sterile instruments. As per the requirements, removal of seed, pulp, hard parts etc. may be performed at a germ-free environment.

The materials may be converted to paste by any mechanical mean using instruments like Mixture and Grinder.

The juices may be extracted out by applying mechanical pressure using proper instruments. Filtration of the materials may be required in some cases. The cut pieces, pulps, juices or any other form of the materials may be kept at low temperature (as 0^0C) or at freezing temperatures (below 0 ^{0}C) before use at next specific purpose/s.

The requirements and procedures discussed in this book should be considered as a model. However, during practical application, modification may be performed as per the plant material, purpose of use and proper presentation.

Chapter III

Evaluation of activity of the collected succulent parts of plants

The phyto-constituents can act as some effective medicines either directly (as the locally applicable medicines or the medicines act on the wall of digestive tract) or their metabolites work in the target system/ organs inside the body. Our presently available analytical systems can identify a good section of the effects of the first type. However, analysis of the second type (study of activity of metabolites produced inside our system) is much more difficult, particularly for those phyto-constituents present in the succulent bio-medicines or bio-products at negligible amounts.

Validation of reported efficacy, study for probable toxicity and therapeutic dose determination of the bio-medicines

Items for production of some succulent herb-based bio-medicines and other bio-products are added as proposals in three tables. Some preliminary research for dosing and toxicity should be performed before marketing them as some effective medicines or healthcare products.

For the preparation of products described in Table 9 and Table 10, validation of traditional claims for beneficial effects on our health is not so much important as these are already in use among a section of the people since a long back. Only preliminary study for dose (quantity for unit consumption) and toxicity (in the unit dose or for calculation of highest quantity to be consumed daily) should be performed before marketing of the products.

But for the proposed plant products described in Table 11, both study for validation of effectiveness, calculation of dose and evaluation of toxicity are important.

Details regarding study pattern for direct antimicrobial efficacy, immuno-stimulant activity and antioxidant activity for validation of reported use of the plant products are described briefly with addition of related links (to get detail description in the concerned articles) at the Chapter VII of Volume 1 of this book (page 20 – 22) [4].

Link for detail guideline to perform Toxicity study and Clinical trials for calculation of therapeutic doses etc. are also added in the Chapter IX of the Volume 1 of this book (Steps towards development of a drug; page 25-26). Further details are available in the related published literatures [5,6,7].

Identification of mechanism of action of bio-medicines: the constraints

Identification of the mechanism of actions of various medicines of synthetic or semi-synthetic origin is presently at a more or less established stage due to intense study performed by many dedicated scientists and research workers for a long time with continuation addition, alteration and modification of the ideas and efforts to collect proves for their establishment.

But it is not so easy to identify and establish the mechanism of action of succulent bio-medicines. There are several reasons behind it.

1.The medicines of synthetic origin (the 'drugs') act as a single molecule in most of the time. The succulent herbs may contain several molecules; some of them are so negligible in amount that they remain below the level of identification through the techniques available in modern analytical science.

2. It is easy to follow a single drug from its ingestion up to the excretion from the body system. But it can not be said for the bio-medicines.

3. Involvement of receptors of the body system may be far more complex in bio-medicines.

4. Many of the proposed bio-medicines are also taken as some nutraceuticals. So, it may be a difficult task to identify their effect only as some medicines.

5. The metabolic products of the present phytochemicals of a single bio-medicine may be very diverse and so it may be very difficult to identify all of them and then perform further studies on them.

6. The concept of study of synthetic medicines may not be applicable to study many bio-medicines due to the fact that the bio-medicines generally do not show their effect instantly. Many of them may act slowly or very slowly in our system.

7. Effects of bio-medicines may be compared with the effects of different xenobiotic residues enter our body and perhaps act very slowly inside our body. But they are very much able to show their detrimental effects on our health.

Same may be said for these bio-medicines, though towards some positive sides.

Chapter IV

Storage of succulent bio-medicines and other bio-products

There is no study report on storage of the bio-medicines collected from the succulent parts of plants, as the system is proposed for the first time.

The reports of previous studies or the already evaluated and accepted procedures on the related materials may guide the researchers to develop effective storage system/s for such bio-medicines. The established techniques are discussed below.

Storage of fresh fruits

1. Highly heat-sensitive products such as raspberries or cherries, the fruit should be pre-cooled prior to storage. Pre-cooling can be accomplished by hydro-cooling (immersion of the fruit in cold water) or vacuum cooling (moistening of the materials and then placing under vacuum in order to induce evaporative cooling).

2. Another effective storage system for fruit is keeping them in cold storage by using refrigerated air.

3. Controlled-atmosphere (CA) storage: In this system, to retard senescence and further deterioration of the fruit, the oxygen and carbon dioxide content of the storage environment are controlled. Generally, oxygen levels are reduced and carbon dioxide levels are increased for that purpose.

Conventional CA depends on the respiration of the fruit to generate carbon dioxide, and the concentration of this gas is controlled by wet scrubbers, hydrated lime, or other commercial carbon dioxide removal systems. Liquid nitrogen and compressed nitrogen gas have also been used to push out the ambient air of the storage facility. In other systems, oxygen is converted to carbon dioxide by reaction with liquid propane or by catalytic burning.

4. Hypobaric storage: This system involves the cold storage of fruit under partial vacuum. Typical conditions include pressures as low as 80 and 40 millimetres of mercury and temperatures of 5° C.

Hypobaric conditions reduce ethylene production and respiration rates and the result is availability of an extraordinarily high-quality fruit even after months of storage [2].

Collection and storage of fruit juices

Processing of the fruit juices require some steps such as washing, extraction, clarification, pasteurisation and cooling before preservation. The whole process is shown in Fig. 1.

Washing

Fruits should be washed before processing. It is generally performed with a high-pressure soak or spray system. Addition of surfactant or detergent may be required to wash out adhered soil attached to the fruits. It also helps to remove various microorganisms responsible for production of different toxins as well as decomposition of the fruits [2]. But it is further important to wash out such detergent or surfactant totally from the fruits afterwards.

Juice extraction:

Preparation

Fruit should be prepared for juice extraction after removing unwanted parts. This may include pitting operations for stone fruit such as apricots, cherries, or plums or peeling for such fruits as pineapples. In one large class of fruit, citrus fruits, juice extraction and separation from the peel are combined. Two major juice extraction systems for citrus exist. One is a reaming technique, in which the fruit is cut in half and the individual halves reamed to extract both the juice and the inner fruit solids. In the second major system, a hole is punched in the fruit and the juice squeezed out at the same time.

If the entire fruit is to be used in the juice, then typically it is disintegrated in a drum grater or a hammer mill. Care must be taken to control disintegration so that the particle size of the mash is compatible with the press system [2].

Pressing

Many different types of press are used for juice extraction. The most traditional is a rack-and frame press, in which ground fruit (mash) is pumped into cloth partitions, called cheeses, which are separated by wooden or metallic racks. After a stack of cheeses has been produced, the press is activated and the juice expressed from the assembly.

Many variations of the rack-and-frame press exist. These include the continuous belt press, the bladder press, and the basket press [2].

Liquefaction

As an alternative to press systems, some processors have gone to total enzymatic liquefaction of the fruit mash. Cellulase and pectinase enzymes are added, and the mash is heated in order to accelerate the enzyme's performance [2].

Clarification:

De-pectinization

If the juice is to be clarified further or concentrated after extraction, treatment with pectinase may be required. The juice is monitored for pectin content using a qualitative pectin check, consisting of combining one-part juice with two parts ethanol. If a gel forms, pectin is still present and de-pectinization must continue. When de-pectinization is complete, a bloc is typically formed by the aggregation of partially degraded pectin-protein aggregates [2].

Filtration

Filtration systems are varied in design, operation, and application. The most traditional system is diatomaceous earth (DE) filtration, in which DE is used to aggregate and collect suspended solids. The DE is collected on filter paper inside the pressure filter as the juice passes through the unit. The resulting juice is sparkling clear. Owing to concern over the cost of DE and its disposal, other filtration processes have been designed. The most successful is membrane filtration, in which hollow fibre; open tubular or ceramic membranes are employed in juice filtration systems [2].

Preservation

Once the juice has been clarified, it is ready to be preserved. In some cases, large reserves of single-strength juice are kept in juice silos after having been pasteurized, but usually the juice is immediately processed into retail or institutional packages. For a single-strength juice packaging line, a typical process is to heat the juice to 88° C and then bottle it. This produces a shelf-stable product.

For producing concentrate, the juice is passed through an evaporator, where the level of soluble solids is typically brought to 70 percent by weight. Retail packages of concentrate are typically filled at 45 percent dissolved solids; at this concentration a three-to-one dilution by the consumer will create a finished product with a soluble solid level of approximately 12 percent [2].

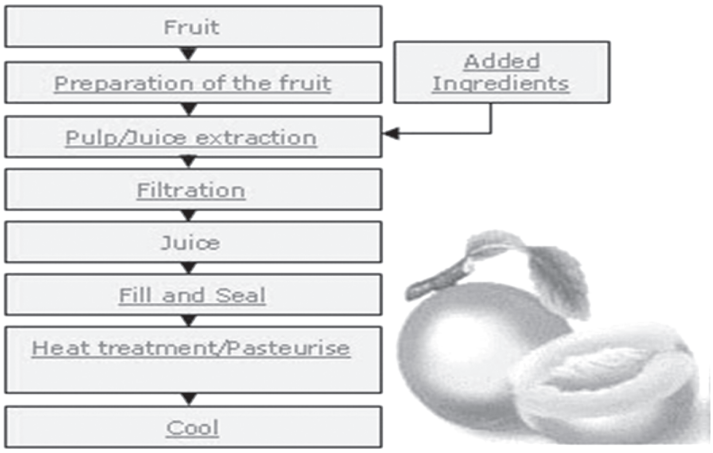

Fig. 1. Steps for fruit-juice production [3].

A novel freezing system for storage of bio-products

In order to achieve extended storage life, the product must be held at a minimum of -23° C [2].

So, after production, all types of bio-products may be stored at some effective low temperature, may be at – 25^0C at deep freezers. During transportation to the wholesalers from the factory or during storage by the wholesalers, it may be performed at the same temperature (– 25^0C). But the retail shops have to sale the products. They may be equipped with a freezing system with some special facilities as shown in Fig. 2.

Top Chamber: (+ 4^0C)
Middle Chamber 2: (0^0C)
Middle Chamber 1: (– 4^0C)
Bottom Chamber: (– 25^0C)

Fig. 2. Design of freezing chambers with different temperatures to stock succulent plant part derived bio-products.

Technically, such freezing equipment is not difficult to prepare.

The retail shopkeepers may store the bio-products for a longer period at the bottom chamber. The middle chamber 1 may be used as per the requirement and schedule for sale of the products. The middle chamber 2 may store the products like frozen fruit pulp, fruit juices or real fruit ice cream etc. for a few hours. The top chamber may be used for preparation of the products like fruit juice to deliver them directly to the customers/ consumers.

Chapter V

Presentation of bio-medicines and other bio-products and addition of other materials with them

Presentation of bio-medicines/ bio-products

It is always better to keep individual phyto-medicines or their preparations separately at individual doses before the time of use. Just before use of such medicines or other healthcare products, if it is necessary to mix them together for better actions, they may be mixed. Separate packaging may be performed for each such item and all of these packages may be kept together inside another full pack after production for marketing.

Addition of other materials - the contemporary methods

Different synthetic chemicals of different classes are used to prepare medicines and sold as such or after addition with some herbal extract/s with them. Many synthetic chemicals are also added with medicines, edible amusement products and cosmetics to retard decomposition of the items or unnecessarily just to attract consumers.

a) Mixing of nature-identical chemicals or diluent extracts of dry herbs with some synthetic medicines or chemicals to market them as 'herbal' products

The contemporary "Herbal" products available in the market generally contain many chemicals of basically synthetic origin. Some synthetic chemicals and/or some modern medicines are added with some 'natural' medicine/s and sold as herbal medicines. These so called 'natural' medicines are actually some 'nature-identical' chemicals in many cases. That means the chemical structure of one/some isolated phytochemicals (or active principles) are identified and then such chemicals are synthesized in the laboratory. These are called as 'nature identical' or 'natural' medicines and added with some synthetic medicines to capture the market in the name of 'Herbal Medicines'.

In some other cases, a little extract of dry part of one or two herb is added with some medicines of synthetic origin and also sold as 'Herbal Medicine' with the same target.

Many so called 'Herbal' or 'Natural' healthcare and oral amusement products also contain the same type of materials. They are also added with many other chemicals of different categories.

Such techniques should be kept outside of the proposed healthcare system.

Table: 1. E- number allotment for main food additives [9].

Category	Items with E number	Category	Items with E number
Synthetic colours (E 100-199)	100–109 yellows 110–119 orange 120–129 reds 130–139 blues & violets 140–149 greens 150–159 browns & blacks 160–199 gold and others	Thickeners, stabilisers and emulsifiers (E 400-499)	400–409 alginates 410–419 natural gums 420–429 other natural agents 430–439 polyoxyethene compounds 440–449 natural emulsifiers 450–459 phosphates 460–469 cellulose compounds 470–489 fatty acids and compounds 490–499 others
Preservatives (E 200-299)	200–209 sorbates 210–219 benzoates 220–229 sulphites 230–239 phenols and formates (methanoates) 240–259 nitrates 260–269 acetates (ethanoates) 270–279 lactates 280–289 propionates (propanoates) 290–299 others	pH regulators and anti-caking agents (E 500-599)	500–509 mineral acids and bases 510–519 chlorides and sulphates 520–529 sulphates and hydroxides 530–549 alkali metal compounds 550–559 silicates 570–579 stearates and gluconates 580–599 others
Antioxidants and acidity regulators (E 300-399)	300–305 ascorbates (vit. C) 306–309 Tocopherol (vit. E) 310–319 gallates and erythorbates 320–329 lactates 330–339 citrates and tartrates 340–349 phosphates 350–359 malates and adipates 360–369 succinates and fumarates 370–399 others	Flavour enhancers (E 600-699)	620–629 glutamates 630–639 inosinates 640–699 others
		Antibiotics (E 700-799)	Commonly used antibiotics
		Miscellaneous (E 900-999)	900–909 waxes 910–919 synthetic glazes 920–929 improving agents 930–949 packaging gases 950–969 sweeteners 990–999 foaming agents
		Other chemicals (E 1100-1599)	For chemicals that do not fall into any group

b) Addition of color, flavor, stabilizer, emulsifier etc.

Different chemical colors, chemical flavors etc. of synthetic origin as well as different synthetic and industrially manufactured sweeteners are added with different processed foods, 'fruit' drinks and medicines. Chemicals in the categories of 'stabilizer', 'emulsifier' etc. are added to give desired taste, shape, special organoleptic feelings etc. to the marketed products. Some of such products contain only some chemicals of synthetic origin and some others contain some nature derived product/s as a part of them. As per the available records, almost all of those added chemicals are having detrimental effects on our health [8]. Chemical additives of food may cause cancer, lead to Alzheimer's, Parkinson's and many diseases related to mental health, including Attention-deficit/hyperactivity disorder (A.D.D.) [1].

In the present situation, different chemicals are in use in different products and most of them are marked by E- numbers. These numbers are practiced in Europe for all approved additives. This numbering scheme has now been adopted and extended by the Codex Alimentarius Commission to internationally identify all additives. Chemicals without that E number are also used. But it is evident from the added list that we are taking a huge number of such chemicals in different names daily (Table 1).

This topic (purpose of use of such chemicals, their effects on health, their toxicity mechanisms etc.) is discussed in details in many good review articles [10, 11].

Relevancy of addition of chemicals in the bio-medicines and other bio-products

Marketing of the proposed bio-medicines and other bio-products of the novel healthcare system ideally may be for their effectiveness only. So, addition of any extra chemical/ material just for marketing purpose or to attract the people should be avoided. For this reason, unnecessary addition of synthetic color, synthetic flavor etc. chemicals should not be permitted during formulation and preparation of such bio-medicines or bio-products.

The proposed bio-medicines and other bio-products should not broaden the way of entry of such toxic chemicals inside our body.

Chapter VI

Different preservation processes commonly used for food preservation

For preservation of succulent bio-medicines and bio-products, different available preservation procedures used to preserve food and food items may be consulted to identify proper technique/s for the required purpose/s.

Dehydration

Dehydration is among the oldest and most common forms of fruit preservation. In dehydration, moisture in the fruit is driven off; leaving a stable food that has moisture content below that at which microorganisms can grow. There are three basic systems for dehydration: sun drying, hot-air dehydration and freeze-drying.

Dehydration has a number of advantages. Dehydrated fruit has a virtually unlimited shelf life when held under proper storage conditions. Drying does not significantly reduce the calories or minerals, and vitamin losses are similar to other preservation methods. In addition, by reducing the weight and the need for refrigeration, handling and transportation costs can be reduced dramatically. Dehydrated fruits are typically reduced in weight by 75 to 90 percent.

Although dehydration offers a convenient product form, it usually requires a careful inactivation of enzymes. This is usually accomplished by blanching of the fruit or by chemical inactivation. Typically, sulphur dioxide is added for its antioxidant and preservative effects. In order to control browning, the fruit is often treated prior to dehydration with sodium sulphate and sodium bisulphate [2].

Freezing

Freezing is also one of the most commonly used processes commercially and domestically used for preserving a very wide range of food including prepared food stuffs which would not have required freezing in their unprepared state. Cold stores provide large volume, long-term storage for strategic food stocks held in case of national emergency in many countries [10].

Freezing of fruits and fruit products is a common consumer practice. Cold temperatures act to retard the spoilage of fruit by inhibiting microbial action and slowing metabolic processes. In order to achieve extended storage life, the product must be held well below the freezing point of water-typically at a minimum of -23° C. Generally, rapid freezing leads to an improved texture upon thawing [2].

A prerequisite for effective freezing is inactivation of fruit enzymes. Traditionally, this is done through blanching or by the addition of a chemical. Blanching consists of heating the fruit for a short time in water or steam prior to cooling and subsequent freezing. The blanch step is intended to inactivate enzyme systems responsible for off-flavours, browning, and softening [2].

Thermal processing

In thermal processing, heat is used to destroy spoilage organisms and to inactivate troublesome enzymes. Enzymes are typically responsible for browning, softening, and the development of off-flavours. For high-acid fruit products the most typical thermal process is canning, in which fruit or fruit products are hot-filled or heated in a hermetically sealed container. The process temperature is generally in the range of 88° C [2].

Vacuum packing

Vacuum-packing stores food in a vacuum environment, usually in an air-tight bag or bottle. The vacuum environment strips bacteria of oxygen needed for survival, slowing spoiling. Vacuum-packing is commonly used for storing nuts to reduce loss of flavour from oxidation [10].

Use of salt

Salting or curing draws moisture from many items as from meat through a process of osmosis. Meat is cured with salt or sugar, or a combination of the two. Nitrates and nitrites are also often used to cure meat and contribute the characteristic pink colour, as well as inhibition of dangerous micro organism, *Clostridium botulinum* [10].

Use of sugar

Sugar is used to preserve fruits, either in syrup with fruit such as apples, pears, peaches, apricots, plums or in crystallized form where the preserved material is cooked in sugar to the point of crystallization and the resultant product is then stored dry. This method is used for the skins of citrus fruit (candied peel), angelica and ginger. A modification of this process produces glace fruit such as glace cherries where the fruit is preserved in sugar but

is then extracted from the syrup and sold, the preservation being maintained by the sugar content of the fruit and the superficial coating of syrup. The use of sugar is often combined with alcohol for preservation of luxury products such as fruit in brandy or other spirits [12].

Pickling

Pickling is a method of preserving food in an edible anti-microbial liquid. Pickling can be broadly categorized as chemical pickling and fermentation pickling.

In chemical pickling, the food is placed in an edible liquid that inhibits or kills bacteria and other micro-organisms. Typical pickling agents include brine (high in salt), vinegar, alcohol, and vegetable oil, especially olive oil but also many other oils. Many chemical pickling processes also involve heating or boiling so that the food being preserved becomes saturated with the pickling agent. Common chemically pickled foods include cucumbers, peppers, corned beef, herring, and eggs, as well mixed vegetables such as piccalilli.

In fermentation pickling, the food itself produces the preservation agent, typically by a process that produces lactic acid [10].

Lye (Sodium hydroxide)

It makes food too alkaline for bacterial growth. Lye will saponify fats in the food, which will change its flavour and texture. Lutefisk uses lye in its preparation, as do some olive recipes. Modern recipes for century eggs also call for lye [10].

Canning and bottling

In this method, air is removed from food and put in airtight cans so that germs do not grow on them. Food items like vegetables, seafood, dairy products etc. are preserved through this method [13].

Canning involves cooking food, sealing it in sterile cans or jars, and boiling the containers to kill or weaken any remaining bacteria. Foods have varying degrees of natural protection against spoilage and may require that the final step occur in a pressure cooker. High-acid fruits like strawberries require no preservatives to can and only a short boiling cycle, whereas marginal-acid fruits such as tomatoes require longer boiling and addition of other acidic elements. Low- acid foods, such as vegetables and meats require pressure canning. Food preserved by canning or bottling is at immediate risk of spoilage once the can or bottle has been opened. Lack of quality control in the canning process may allow ingress of water or micro-organisms. Most such failures are rapidly detected as decomposition within the can causing gas production and the can will swell or burst. However, there have

been examples of poor manufacture (under processing) and poor hygiene allowing contamination of canned food by the obligate anaerobe *Clostridium botulinum*, which produces an acute toxin within the food, leading to severe illness or death. This organism produces no gas or obvious taste and remains undetected by taste or smell. Its toxin is denatured by cooking, though, cooked mushrooms, handled poorly and then canned, can support the growth of *Staphylococcus aureus*, which produces a toxin that is not destroyed by canning or subsequent reheating [14].

Jellying

Food may be preserved by cooking in a material that solidifies to form a gel. Such materials include gelatine, agar, maize flour and arrowroot flour. Some foods naturally form a protein gel when cooked such as eels and elvers etc. Many jugged meats are also jellied. Fruit preserved by jellying is known as jelly, marmalade, or fruit preserves. In this case, the jellying agent is usually pectin, either added during cooking or arising naturally from the fruit. Most preserved fruit is also sugared in jars. Heating, packaging, acid and sugar provide the preservation [10].

Potting

A traditional British way of preserving meat (particularly shrimp) is by setting it in a pot and sealing it with a layer of fat. Also common is potted chicken liver [10].

Jugging

Meat can be preserved by jugging, the process of stewing the meat (commonly game or fish) in a covered earthenware jug or casserole. The meat to be jugged is usually cut into pieces, placed into a tightly-sealed jug with brine or gravy, and stewed. Red wine and/or the animal's own blood are sometimes added to the cooking liquid. Jugging was a popular method of preserving meat until the middle of the 20th century [10].

Irradiation

Irradiation of food is the exposure of food to ionizing radiation; either high-energy electron X-rays from accelerators, or by gamma rays (emitted from radioactive sources as Cobalt-60 or Caesium-137). The treatment has a range of effects, including killing of bacteria, molds and insect pests, reducing the ripening and spoiling of fruits, and at higher doses including sterility. The technology may be compared to pasteurization; it is sometimes called 'cold pasteurisation', as the product is not heated. Irradiation is not effective against viruses or prions; it cannot eliminate toxins already formed by microorganisms, and is

only useful for food of high initial quality. The radiation process is unrelated to nuclear energy, but it may use the radiation emitted from radioactive nuclides produced in nuclear reactors. Ionizing radiation is hazardous to life (hence its usefulness in sterilization); for this reason, irradiation facilities have a heavily shielded irradiation room where the process takes place. Radiation safety procedures ensure that neither the workers in such facility nor the environment receive any radiation dose from the facility. Irradiated food does not become radioactive, and national and international expert bodies have declared food irradiation as wholesome. However, the wholesomeness of consuming such food is disputed by opponents and consumer organisations. National and International expert bodies have declared food irradiation as 'wholesome', UN-organisations as WHO and FAO are endorsing to use food irradiation. International legislations on whether food may be irradiated or not varies worldwide from no regulation to full banning [15]. It is estimated that about 500,000 tons of food items are irradiated per year worldwide in over 40 countries. These are mainly spices and condiments with an increasing segment of fresh fruit irradiated for fruit fly quarantine [16, 17].

Modified atmosphere

Modifying atmosphere is a way to preserve food by operating on the atmosphere around it. Salad crops which are notoriously difficult to preserve are now being packaged in sealed bags with an atmosphere modified to reduce the oxygen (O_2) concentration and increase the carbon dioxide (CO_2) concentration. There is concern that although salad vegetables retain their appearance and texture in such conditions, this method of preservation may not retain nutrients, especially vitamins. Grains may be preserved using carbon dioxide. A block of dry ice is placed in the bottom and the can is filled with grain. The can is then "burped" of excess gas. The carbon dioxide from the sublimation of the dry ice prevents insects, molds, and oxidation from damaging the grain. Grain stored in this way can remain edible for five years. Nitrogen gas (N_2) at concentrations of 98% or higher is also used effectively to kill insects in grain through hypoxia. However, carbon dioxide has an advantage in this respect as it kills organisms through both hypoxia and hypercarbia, requiring concentrations of only 80%, or so. This makes carbon dioxide preferable for fumigation in situations where a hermetic seal cannot be maintained [18].

Burial in the ground

Burial of food can preserve food due to a variety of factors: lack of light, lack of oxygen, cool temperatures, pH level, or desiccants in the soil. Burial may be combined with other methods such as salting or fermentation. Many root vegetables are very resistant

to spoilage and require no other preservation other than storage in cool dark conditions, for example by burial in the ground, such as in a storage clamp. Century eggs are created by placing eggs in alkaline mud (or other alkaline substance) resulting in their "inorganic" fermentation through raised pH instead of spoiling. The fermentation preserves them and breaks down some of the complex, less flavourful proteins and fats into simpler more flavourful ones. Most foods can be preserved in soil that is very dry and salty (thus a desiccant), or soil that is frozen [10].

Controlled use of micro-organism

Some foods, such as many cheeses, wines, and beers can be kept for a long time because their production uses specific micro-organisms that combat spoilage from other less benign organisms. These micro-organisms keep pathogens in check by creating an environment toxic for themselves and other micro-organisms by producing acid or alcohol. Starter micro-organisms, salt, hops, controlled (usually cool) temperatures, controlled (usually low) levels of oxygen and/or other methods are used to create the specific controlled conditions that will support the desirable organisms that produce food fit for human consumption [10].

High pressure food preservation

High pressure food preservation refers to high pressure used for food preservation. Pressed inside a vessel exerting 70,000 pounds per square inch or more, food can be processed so that it retains its fresh appearance, flavour, texture and nutrients while disabling harmful microorganism and slowing spoilage. It is used for products ranging from orange juice to guacamole to deli meats and widely sold [19].

Addition of preservatives: the current status

Ideal properties of preservatives

1. Should be non-irritant.
2. Should maintain product consistency.
3. Should maintain palatability and wholesomeness.
4. Should not be toxic.
5. Should be stable (physically and chemically).
6. Should be compatible with all other ingredients
7. Should be act as good antimicrobial agent
8. Should be potent in action.
9. Should have higher shelf life [20].

Function of preservatives

1. To increase or maintain nutritional value of food.
2. To enhance quality and to reduce wastage.
3. To enhance consumer acceptability
4. To inhibit the growth of microbes.
5. To increase reasonably shelf life of processed foods [21].

Classification of preservatives

There are two main classes of preservatives:

I. Class I: Food preservatives obtained from nature are under this class. Example: salt, sugar, vinegar, spices, honey, edible oils etc.

II. Class II: This class includes chemical, semi synthetic or synthetic food preservatives. Example: Benzoates, sorbates, nitrites and nitrates of potassium, sulphites, glutamates, glycerides etc. [22].

Preservation process

Common preservation processes are as follows.

1. Heating to kill or denature micro-organisms (e.g. boiling)
2. Oxidation (e.g. use of sulphur dioxide)
3. Toxic inhibition (e.g. smoking, use of carbon dioxide, vinegar, alcohol etc.)
4. Dehydration (drying)
5. Osmotic inhibition (e.g. use of syrups)
6. Low temperature inactivation (e.g. freezing)
7. Ultra high-water pressure (e.g. fresherised, a kind of "cold" pasteurization, the pressure kills naturally occurring pathogens, which cause food deterioration and affect food safety) [10].

Type of preservatives

Preservatives are categorized into 3 types.

1. **Antimicrobial preservatives**

These preservatives destroy or delay the growth of bacteria, yeast and molds, e.g. nitrites and nitrates prevent botulism in meat products. Sulphur dioxide prevents further degradation in fruits, wine and beer. Benzoates and sorbates are anti-fungal agents used in jams, salads, cheese and pickles [22].

2. **Anti-oxidant preservatives**

These slow or stop the breakdown of fats and oils in food that occurs in the presence of oxygen leading to rancidity. There are three types of antioxidants.

a) **True antioxidants** such as Butylated hydroxytoluene (BHT) and Butylated hydroxy anisole (BHA) block chain reactions by reacting with free radicals.

b) **Reducing agents** such as ascorbic acid has lower redox potential than the drug or excipients they are protecting.

c) **Antioxidant synergists** such as Sodium edetate enhance the effects of other antioxidants [22, 23].

3. **Anti-enzymatic preservatives**

These block the enzymatic processes such as ripening occurring in foodstuffs even after harvest. Example: Erythorbic acid and citric acid stop the action of enzyme phenolase that leads to a brown colour on the exposed surface of cut fruits or potato [22].

The contemporary methods of using preservatives of synthetic origin

Different preservatives are used in different food-based products and medicines. The toxicity studies performed before giving the permission for marketing of these products is basically some short – term effect study among some models. No guaranty can be given for their non-toxicity in long term continuous use or cumulative gathering (of thousands of such chemicals inside the body) by performing any scientific study of present time [8].

Some commonly used synthetic preservatives

Some commonly used preservatives are shown along with their targeted food products in Table 2.

Impact of synthetic preservatives on our health: some reports

The presently used chemical preservatives have many toxic effects on our health. Some of the identified detrimental health effects of preservatives are shown in Table 3.

As the proposed bio-medicines and bio-products are designed for transportation up to the patient or consumer level under cold chain, so there may be little requirement of addition of any preservative of any category. If some preservative is still required, only the preservatives purely of natural origin may be searched out for that purpose.

Preservatives of natural origin

Several chemical compounds present in plants have the ability to replace synthetic

Table 2. Utilization of preservatives in some common products [22, 24].

Preservatives	Targeted food or food products
Ascorbic acid (vitamin C)	Fruit products, acidic foods
Benzoic acid	Fruit products, acidic foods, margarine
BHA (butylated hydroxy anisole)	Bakery products, cereals, fats and oils
BHT (butylated hydroxytoluene)	Bakery products, cereals, fats and oils
Calcium lactate	Dairy products, olives, frozen desserts, jams, jellies
Calcium propionate	Breads and other baked goods
Calcium sorbate	Syrups, dairy products, cakes, mayonnaise, margarine
EDTA (ethylenediaminetetraacetic acid)	Dressings, margarine, canned vegetables
Methylparaben	Beverages, dressings, relishes
Potassium propionate	Breads and other baked goods
Potassium sorbate	Dairy products, syrups, cakes, processed meats
Propionic acid	Breads and other baked goods
Propylparaben	Beverages, cake, pastries, relishes
Propyl gallate	Cereals, snack foods, pastries
Sodium benzoate	Fruit products, margarine, acidic foods
Sodium nitrate and nitrite	Cured meats, fish, poultry
Sodium propionate	Breads and other baked goods
Sodium sorbate	Dairy products, mayonnaise, processed meats, fermented products
Sorbic acid	Dairy products, fruit products, syrups, sweets, beverages, fermented products
TBHQ (tert-butyl hydroquinone)	Snack foods, fats, and oils
Tocopherols (vitamin E)	Oils and shortenings
Sulphur dioxide gas	Fruit processing
Sodium sulphite, bisulphite or meta-bisulphite	Fruit processing
Potassium sulphite, bisulphite or meta-bisulphite	Fruit processing
Sorbic acid	Fruit processing
Benzoic acid	Fruit processing
Citric acid	Fruit processing
Malic acid	Fruit processing
Propionic acid	Fruit processing

Table 3. Health hazards of some commonly used food preservatives [22].

Preservative	Hypersensitivity (H)	Asthma (A)	Cancer (C)
Potassium & Calcium Sorbates, Sorbic Acid	H	A	-
Benzoic Acid	H	A	-
Sodium Benzoate	H	A	C
Propylparaben	-	A	-
Sulphur Dioxide	H	A	-
Sodium Met bisulphite	-	A	-
Potassium Bisulfite	H	A	-
Hexamethylene Tetraamine	-	-	C
Sodium Nitrite	H	A	C
Sodium or Potassium Nitrate	H	-	C
Calcium or Potassium or Sodium Propionates, Propionic Acid	H	A	-
Propyl Gallate	-	A	C
Tert Butylhydroquinone (TBHQ)	H	A	-
Butylated Hydroxy anisole (BHA)	H	A	C
Butylated Hydroxytoluene (BHT)	H	A	C

preservatives thereby helping to conserve food and food products. Among them, saponin, flavonoids, thiosulfinates, glucosinolates, phenolics and organic acids are important. However, the main components of plants with antimicrobial action are phenolic compounds such as terpenes, aliphatic alcohols, aldehydes, ketones, acids and isoflavonoids [25].

Plants contain a huge number of components. The most modern laboratories with updated technologies cannot give us guarantee about identification of each and every component of even of a single plant. A huge number of phyto-components are remaining in each plant or plant part at some very negligible amounts which become lost during chemical extraction process applied to obtain phytochemicals from any plant part. These may have very important role when remain together [26]. So, the traditionally used plant part/s or any of their natural extracts (not chemical extracts) are not less important than the isolated active compounds or chemically synthesised compounds used as preservative. The chemical antioxidant preservatives may be replaced by plant derived natural antioxidants in many cases. The list of class 1 preservatives may be increased by adding many nature gifted plant products.

Table 4 contains a list of various natural products traditionally used as preservatives (as per the available records).

Table 4. List of natural products with preservative activity [27, 28, 29, 22, 30, 31, 23, 32, 33, 34, 35].

Type of natural product	Names/source of the natural products
Part of herbs	Oregano (*Origanum vulgare* L.), Basil (*Ocimum tenuiflorum* L.), Neem (*Azadirachta indica* A.Juss), Coriander (*Coriandrum Sativum* L.), Bay leaf (*Laurus nobilis* L.), Marjoram (*Origanum majorana* L.), Berry fruits [Blueberries (*Vaccinium corymbosum* L.), Strawberries (Fragaria ananassa L.), Blackberries (*Rubus fruticosus* L.)], Turmeric (*Curcuma longa* L.), Green tea [*Camellia sinensis* (L.) Kuntze], Soy [*Glycine max* (L.) Merr.], Sarsaparilla (*Smilax ornata* Hook.f.), Raisin (dried grapes: *Vitis vinifera* L. and others), Hoptree (*Ptelea trifolia* L.), Coffee (*Coffea arabica* L.), Wasabi extract [roots of *Eutrema japonicum* (Miq) Koidz.], Beetle leaf *(Piper betle* L.), Rosemary (*Rosmarinus officinales* L.), Ylang ylang [*Cananga odorata* (Lam.) Hook.f. & Thomson], Onion (*Allium cepa* L.), Australian Kakadu plum (*Terminalia ferdinandiana* Exell.), Drumstick root *(Moringa oleifera* Lam.) etc.
Herb compounds	Algin (from seaweed), Citrus seed extract, Vitamin E oil (from Wheat germ oil, Sunflower oil etc.), Carrageenan (from seaweed), Citric acid (from lemon and lime), Erythorbic acid (a vegetable-derived food additive), Guar Gum (from seeds of the guar plant *Cyamopsis tetragonoloba* L.), Citrous seed extract (from seeds, pulp and white membranes of grapefruit *Citrus paradise*), Food acids (like vinegar, citric acid, tartaric acid, malic acid, fumaric acid, lactic acid, sorbic acid), naturally occurring parabens (from blueberries, blackcurrants, mango, cocoa beans, vanilla, and strawberries), Verdad F32 (mixture of beet, cane sugar, corn and tapioca) etc.
Spices	Cinnamon (*Cinnamomum verum* J. Presl.), Pomegranate (Bedana: *Punica granatum* L.), Thyme (*Thymus vulgaris* L.), Nutmeg (*Myristica fragrans* Houtt.), Saffron (*Crocus sativus* L.), Chilli pepper (*Capsicum annuum* L.), Garlic (*Allium sativum* L.), Clove [*Syzygium aromaticum* (L.) Merr.], Ginger *(Zingiber officinale* Roscoe.) etc.
Essential Oils	Coriander seed (*Coriandrum Sativum* L.), Thyme (*Thymus vulgaris* L.)**,** Clove bud [*Syzygium aromaticum* (L.) Merr.], Sage (*Salvia officinalis* L.), Rosemary (*Rosmarinus officinales* L.), Oregano (*Origanum vulgare* L.), Cinnamon (*Cinnamomum verum* J. Presl.), Mustard seed [*Brassica juncea* (L.) Czern.], Flaxseed (*Linum usitatissimum* L.), Olive (*Olea europaea* L.), Thyme (*Thymus vulgaris* L.) etc.
Animal/ bird/ insect origin product	Honey, Chitosan, Whey, Lysosomes of duck egg and chicken egg white, Propolis, Lactoferrin (from saliva, milk etc.)
Natural substance	Salt, Sugar, Vinegar, Glycerine, Alcohol etc.
Others	Vitamin E, Organic acids (as Lactic and Acetic acid), Hydrogen peroxide (H_2O_2), Bacteriocin or Bacteriocin-like substances, Alcohol, Carbon di oxide. Niacin (secreted by *Lactococcus lactis*), Diatomaceous earth etc.

Table 5. Essential oils from plant source may have the ability to act as food preservatives [36].

Plant	Scientific name	Main components of Essential oil
Basil	*Ocimum basilicum*	Linalool/methylcavicol
Oregano	*Origanum vulgare*	Thymol/ carvacrol
Rosemary	*Rosmarinus offinicalis*	Camphor/1,8-cineole/borneol
Sage	*Salvia officinalis*	Thujone/1,8cinole/borneol/camphor
Thyme	*Thymus vulgares*	Thymol / carvacrol
Coriander	*Coriandrum sativum*	Linalool/ E-2-decanal
Allspice	*Pimenta diocia*	Eugenol/β-caryophyllene
Cinnamon	*Cinnamonum zeylanicum*	Cinnamic aldehyde/ eugenol
Clove	*Syzgium aromaticum*	Eugenol /eugenyl acetate
Mustard	*Brassica*	Allyl isothiocyanate
Nutmeg	*Myristica fragrans*	Myristicin/a-piene/Sabinene
Vanilla	*Vanilla planifola, V. pompona,V. tahitensis*	Vanillin
Bergamot	*Citrus bergamia*	Limonene/ linalool
Eucalyptus	*Eucalyptus globules*	Eucalyptol
Lemon	*Citrus limon*	Limonene/ valencene/ ocimene

Essential oils (E.O.)

Essential oils of many medicinal plants are traditionally used as medicines. Some of them are used as preservatives also (Table 5). But each essential oil contains many phytochemicals and all of them are perhaps not identified. It can be understood from an added example (Table 6).

Searching of effective preservatives for the bio-medicines and other bio-products

From thousands of years ago, people residing in the remote areas are habituated in use of many preservatives of natural origin. Different vegetable oils, plant part paste or extracts, different plant derived natural sugar solutions, salts etc. are used in such purposes. Occasional exposure of the preserved materials to the Sunlight was a very common practice as along with other effects, Ultra Violet rays and heat of the Sunlight is having the ability to kill micro-organisms present in the stored materials.

The proposed bio-medicines and other bio-products may be scheduled to be transported under cold chain up to the consumers' home. So, there may be a very little scope of use of any preservative in these products. If addition of preservative is felt necessary, the natural preservatives should be selected to serve the purpose. The nature identical compounds, synthetic chemicals etc. should not be considered for such purposes, as it is outside and

Table 6. Main components of the essential oil extracted from *Origanum vulgare* L. subsp. *hirtum* leaves and stems [37].

Component	Percentage (%)
α-pinene	0.6
α-thujene	0.7
camphene	0.2
β-pinene	0.4
myrcene	1.3
α-terpinene	0.8
limonene	5.6
γ -terpinene	3.7
p-cymene	5.8
linalool	0.6
β-caryophyllene	2.3
terpinen-4-ol	0.8
α-terpineol	0.3
borneol	0.7
thymol	1.8
carvacrol	70.1

against the mission for preparation of medicines and healthcare products under that novel healthcare system.

The industry-made sweeteners, both from natural origin (as Sugar from Sugarcane) or synthetic origin (as Saccharine etc.) may have detrimental effects on our health and so may be avoided during selection of preservative for any bio-medicine or bio-product.

The fruit pulp or fruit juices may be added with Mustard oil, Olive oil, Honey, salt and different plant derived natural sugar solutions (may be natural sap of some trees (from young inflorescence of *Borassus flabellifer* L., Family: Arecaceae or *Phoenix dactylifera* L. Family: Arecaceae etc.). These can be used as such after making them germ free or after concentrating them as per the requirements. All these can act as natural sweetener or taste enhancer as well as preservative after proper study of their efficacy. Naturally derived vegetable oils may be used as such, but the hydrogenated vegetable oils should never be used as a preservative as these contain a very toxic form of fats, the trans fats [38].

The previously added study reports (Table 4 and Table 5) may help in identification of such useful natural preservatives.

Chapter VII

Packaging procedures and materials used for packaging

Various contemporary packaging procedures and packaging materials may be analyzed for their effective use in succulent bio-medicines and other bio-products.

Packaging of fresh fruits

1. Plastic made bag or overwrap with air passing facility is commonly used for packaging of fresh fruits.

But due to increased importance of high-quality fruits, efforts are made to develop improved packaging.

2. Studies are performed primarily in the area of Modified-Atmosphere Packaging (MAP). In this type of packaging, the barrier properties of the material are carefully selected according to the respiration characteristics of the fruit. The goal is to allow an exchange of gases and moisture that produces the optimal storage environment.

3. Smart films: these films not only produce the optimal atmosphere for storage of the fruits, but also change their barrier properties depending on the ambient temperature and on the respiration rate of the particular fruit [2].

Packaging of healthcare products for external use

The commonly used packaging materials may be employed for that purpose after a minimum quality evaluation. Along with other effective alternatives, the non-toxic and non-reactive plastics which have no effect on adhered bio-medicines may also be considered for that purpose. Effect of storage temperature (up to - 80^0C) must also be analyzed before finalization of the material for particular purpose.

Packaging of unaltered fruit juices, fruit pulps or fruit ice-creams

The packaging materials which can also be considered as some food may be given preference to pack these edible bio-products. In other cases, the packaging material should be nontoxic, consumer may eat them or may use them as some disposable cover of the product. The ice cream cones or cones made by different carbohydrates may be used in that purpose. Steamed boiled powder of the crops like Maize [*Zea mays* L. Family:

Poaceae], Rice [*Oryza sativa* L. Family: Poaceae], Pearl millet [*Pennisetum glaucum* (L.) R.Br. Family: Poaceae], Oat [*Avena sativa* L. Family: Poaceae], Barley [*Hordeum vulgare* L. Family: Poaceae], Wheat [*Triticum aestivum* L. Family: Poaceae], Potato [*Solanum tuberosum* L. Family: Solanaceae], Sweet potato [*Ipomoea batatas* (L.) Lam., Family: Convolvulaceae], Sorghum [*Sorghum bicolor* (L.) Moench. Family: Poaceae], Tapioca [*Manihot esculenta* Crantz. Family: Euphorbiaceae], Sago [*Metroxylon sagu* Rottb. Family: Arecaceae], Arrowroot [*Maranta arundinacea* L. Family: Marantaceae] etc. may work as some edible packaging material.

In absence of such materials, the edible packaging materials like collagen and/or cellulose etc. may also be tried. In the cases where no such edible material is available, non-toxic other packaging materials may be used as disposable cover of the product.

But in many other cases, encapsulation of the bio-medicines or other bio-products may be required for better storage, transportation and use at consumers level. For this, identification and selection of proper encapsulating materials is very important.

Chapter VIII

Encapsulation of edible bio-medicines, unaltered fruit parts and other bio-products

For encapsulation of the bio-medicines, unaltered fruit products etc. before storage at various negative temperatures and their reconstitution before use, the presently available tools and research findings may be analyzed. A brief analysis of various related parameters of such techniques and materials may lead to identify the effective procedure/s.

Encapsulation of edible materials

Encapsulation is a process to entrap active agents within a carrier material and it is a useful tool to improve delivery of bioactive molecules and living cells into foods. Materials used for design of protective shell of encapsulates must be food-grade, biodegradable and able to form a barrier between the internal phase and its surroundings [39].

Reasons for encapsulation

There are number of reasons for encapsulation of materials.

1) Encapsulation may provide barriers between sensitive bioactive materials and the environment, and thus, can allow taste and aroma differentiation, mask bad tasting or smelling, stabilize food ingredients or increase their bioavailability.

2) It can provide improved stability in final products and during processing.

3) It causes less evaporation and degradation of volatile actives, such as aroma.

4) It is used to mask unpleasant feelings during eating, such as bitter taste and astringency of materials.

5) Prevention of reaction with other components in food products such as oxygen or water.

6) In addition to the above, encapsulation may be used to immobilize cells or enzymes in food processing applications, such as fermentation process and metabolite production processes [39].

Encapsulating materials used in food industry

A multitude of substances are known which can be used to entrap, coat, or encapsulate solids, liquids, or gases of different types, origins, and properties. However, only a limited number thereof have been certified for food applications as "generally recognized as safe" (GRAS) materials. It is worth mentioning that the regulations for food additives are much stricter than for pharmaceuticals or cosmetics. Consequently, some compounds, which are widely accepted for drug encapsulation, have not been approved for use in the food industry. Moreover, different regulations can exist for different continents, economies, or countries, a problem which has to be addressed by food producers who wish to export their products or who intend expanding their markets [40].

Encapsulation procedures

There are number of techniques available for encapsulation of food compounds. Since encapsulating compounds are very often in a liquid form, many technologies are based on drying. Different techniques like spray drying, spray-bed-drying, fluid-bed coating, spray-chilling, spray-cooling, freeze-drying, melt-extrusion or melt injection are available to encapsulate active agents [39, 40].

Some commonly used methods are discussed below.

1) **Dripping**

It consists of extruding droplets from a nozzle in gentle conditions. Droplets may be solidified by cooling or by gelification. Productivity may be increased by forming a liquid jet and breaking it into small droplets, multiplying nozzles or working with spinning devices. The main advantage of this technology is the low size dispersion of the microcapsules. The main drawback is the productivity [41].

2) **Spraying**

That is one of the oldest approaches for producing capsules. The small droplets are either cooled down (hot melt system) or dried (polymer solution). The use of spray drying is largely developed in the food industry, as the process is very similar to the one employed to produce classical food powder (e.g. milk powder). The technology allows large productions. However, the efficacy regarding protection of the actives is not always satisfactory [41].

3) **Dispersed emulsion**

The droplets may be turned into microcapsules by different processes. In the food

industry, the main method used is coacervation, which consists first in dispersing an oil phase (containing the active to encapsulate) in a polymer solution, and then inducing the precipitation of the polymer(s) at the interface of the droplets. If the productivity is very good, this method has an important drawback: crosslinking with glutaraldehyde, a non-food grade molecule, is necessary most of the time to obtain stable microcapsules [41].

4) **Spray coating**

It consists of fluidizing a powder (in a fluid bed or a pan) and spraying a coating solution on the fluidized particles. The coating is solidified by drying (polymer solution) or cooling (melt system). This is the most promising method in terms of performances and flexibility, but process costs have to be significantly reduced [41].

5) **Particle suspension**

Particles may also be suspended in a solution. Interactions between particles and the solution result in the formation of a coating layer around the particles. No process based on this technique seems to be really employed at the moment in the food industry [41].

Constraints in encapsulation of biological materials

Several constraints make the development of an encapsulation process difficult. First, encapsulation is an extra cost, which has to be minimized to be economically acceptable. This applies to the materials used to "build" the microcapsules, but also to the equipment or processing conditions. The number of food-grade materials suitable for microencapsulation is also very limited (some polysaccharides, a few lipids etc.). In the pharmaceutical industry, despite the strict rules to be respected for approval, many more materials are available. Consequently, the food engineer has to play finely with the coating/membrane formulation to achieve appropriate and specific properties [41].

Molecular inclusion in cyclodextrins and liposomal vesicles are more expensive technologies, and therefore, less exploited in encapsulation [39].

Selection criteria of materials for encapsulation [39].

The most important criteria for selection of an encapsulation material is its efficacy to add required qualities to the encapsulated materials.

A. It should provide to the final product,

a) potential restrictions for the coating material,

b) concentration of encapsulates,

c) type of release,

d) stability requirements,
e) cost constrains.

B. Materials used for design of protective shell of encapsulates must be
a) food-grade,
b) biodegradable
c) able to form a barrier between the internal phase and its surroundings.
d) have to provide maximal protection of the active material against environmental conditions,
e) have to hold materials within capsule structure during processing and storage under various conditions,
f) not to react with the encapsulated material,
g) to have good rheological characteristics at high concentration if it is needed and
h) to have easy work ability during the encapsulation.

Presently used encapsulating materials

Different encapsulating materials are listed in Table 7. Those are also discussed briefly.

A. Starch and Starch derivatives

Among the commonly used starches, Amylose and Amylopectin are important.

Chemical, biochemical, and physical modifications of starch are already known. Many functional derivatives of starch are marketed including cross-linked, oxidized, acetylated, hydroxy propylated and partially hydrolyzed molecules. These are considered as usable Starch derivatives. The aim of starch modification is to alter the structure and affect the hydrogen bonding in a controllable manner in order to enhance and extend the industrial applicability [40].

Commonly used Starch derivatives are Maltodextrins, Syrups, Dextrins, Cyclodextrin, Polydextrose etc.

Modified starch and maltodextrin have been used for coating and encapsulation by several technologies including spray-drying, fluidized bed spray-drying, fluidized bed granulation, compacting, and most importantly extrusion. Molecular inclusion is possible with cyclodextrins. Maltodextrins are cheaper than Gum Arabic and are, therefore, in some cases recommended as a partial substitute in encapsulation [40].

Table 7. Materials suited for microencapsulation in the food industry [40].

Origin	Carbohydrate polymer	Protein	Lipid
Plant	Starch	Gluten (corn)	Fatty acids/alcohols
	– Derivatives	Isolates (pea, soy)	Glycerides
	Cellulose		Waxes
	– Derivatives		Phospholipids
	Plant exudates		
	– Gum arabic		
	– Gum karaya		
	– Mesquite gum		
	Plant extracts		
	– Galactomannans		
	– Soluble soybean		
	Polysaccharide		
Marine	Carrageenan		
	Alginate		
Microbial/animal	Xanthan	Caseins	Fatty acids/alcohols
	Gellan	Whey proteins	Glycerides
	Dextran	Gelatin	Waxes
	Chitosan		Phospholipids (Shellac)

Commercial sources of starch

Main commercial sources of starch are

a) Cereal grain seeds: maize (corn), wheat, rice, sorghum etc.

b) Roots and tubers: potato, sweet potato, tapioca (cassava), arrowroot etc.

c) Stems and pith: As sago [40].

B. Cellulose derivatives

Food grade cellulose derivatives may be of different types.

a) Methylcellulose

b) Ethyl cellulose

c) Hydroxypropyl cellulose

d) Hydroxypropyl methyl cellulose

e) Ethyl methyl cellulose

f) Carboxy methyl (Na) cellulose

g) Ethyl hydroxyethyl cellulose
h) Crosslinked Carboxy methyl cellulose [40].

C. Plant exudates and extracts

Gum arabic (Gum senegal) [Source: *Senegalia senegal* (L.) Britton. Family: Fabaceae].
Gum tragacanth [Source: *Astragalus spp.*].
Gum Karaya [Source: *Sterculia urens* Roxb. Family: Malvaceae *or Cochlospermum spp.*].
Guar gum [Source: *Cyamopsis tetragonoloba* (L.) Taub. Family: Fabaceae].
Locust bean gum [Source: *Ceratonia siliqua* L. Family: Fabaceae].
Tara gum [Source: *Tara spinosa* (Feuillée ex Molina) Britton & Rose. Family: Fabaceae].
Mesquite [Source: Gum *Prosopis spp.*]

However, a wide range of exudates from other trees and shrubs are also harvested and consumed in their countries of origin. These gums are generally harvested from wild growing trees [40].

D. Pectins

Pectins are isolated from the citrus peel, orange peel, and residues from the extraction of citrus juice, citrus oil, and apple juice. Hot aqueous mineral acid is used to extract the raw material with the objective of obtaining pectins of high molar mass at high concentration [40].

E. Soluble Soybean polysaccharide

It is extracted from Okara, the residue after oil and soy protein extraction from soybean [40].

F. Marine extracts

Seaweed can be regarded as another almost unlimited source of different types of polysaccharides for many industrial applications. Some of them have been found to be useful for encapsulation in the food sector [40].

Carrageenans

Carrageenans are prepared from red seaweed (*Rhodophycae*). Different seaweeds produce different carrageenans. *Chondrus crispus, Eucheuma cottonii, Eucheuma spinosum, Gigartina, Furcellaria* etc. can give us different carrageenans [40].

Alginate

Alginates are quite abundant in nature. Coercial sodium alginates are generally produced from marine brown algae, though they may also be synthesized as an exocellular material by some bacteria also [40].

G. Microbial and Animal polysaccharides

Polysaccharides produced biotechnologically by bacteria are biopolymers with novel and partially unique functional properties. Examples, which are interesting for food applications are xanthan, gellan, and curdlan,

Xanthan

The *Xanthomonas campestris* bacterium produces the xanthan gum in a pure culture of the bacterium by an aerobic fermentation process in a glucose medium. Use of different strains or fermentation conditions may give rise to differing degrees of acetylation and pyruvylation. Xanthan may contain cellulases, which prevents its use with cellulose derivatives.

Gellan

Gellan is prepared commercially by aerobic submerged fermentation from the microorganism *Sphingomonas elodea.*

Dextran

Microbial fermentation processes of sucrose yield dextrans, which are commercially supplied as powders or solutions.

Chitosan

Chitin, the main source of chitosan, has been evaluated to be as abundant as cellulose. The main process of obtaining chitosan is through alkaline de-acetylation of crustacean chitins. It is also available in some microorganisms and certain fungi [40].

H. Protein derivatives

Proteins are natural macromolecules composed of linear chains of amino acids. The possible sequences and frequency of 20 existing amino acids, more precisely 19 amino acids and one imino acid [40].

Gluten

Gliadin and glutenin exist, conjoined with starch, in the endosperm of some grass-

related grains, notably wheat, rye, and barley. Being insoluble in water, they can be purified by washing away the associated starch. However, the unique properties of wheat proteins have stimulated an interest in their use for other applications than traditional ones.

Milk Proteins

Bovine milk contains, in addition to water, lactose, fat, and other minor components, about 3.0–3.6 wt. % proteins. Of this, caseins and whey proteins are the two major fractions.

Caseins

Caseins are generally manufactured from the skim milk by destabilizing the micelles. Numerous processes are known. The main products obtained are mineral acid casein, lactic acid casein, and rennet casein.

Fractionation is possible and other caseinates may be obtained by different manufacturing processes. Spray-dried sodium caseinate is the most commonly used water-soluble caseinate.

Whey Proteins

Whey is a by-product of cheese or casein production and has several commercial uses. Whey proteins primarily include beta-lactoglobulin, alpha-lactalbumin, serum albumin, immunoglobulins, and also numerous minor proteins. These may be used in manufacture of edible films or microencapsulation of different ingredients [40].

Gelatin

Gelatins do not occur naturally but are manufactured from collagens by processes that destroy the secondary and higher structures of collagen. Collagen is the major constituent of all white fibrous connective tissue occurring in animals.

I. Lipids

Characteristic for lipids is their general insolubility in water; they are hydrophobic. Lipids involve molecules and substances of large diversity and structural variety such as oils, fats, waxes and phospholipids [40].

Fatty acids and Fatty alcohols

Fatty acids are produced by the hydrolysis of the ester linkage of naturally occurring fats and oils, which are in general triglycerides. Glycerol is obtained as the byproduct from this process.

Reduction of fatty acids yields fatty alcohols.

Glycerides

Triglyceride (triacylglycerol, triacyl glyceride), diglyceride (diacyl glycerol), and monoglyceride (monoacyl glycerol) belong to the family of glycerides. Triglyceride is the main constituent in animal fats and plant/vegetable oils. Most natural fats contain a mixture of different triglycerides.

Waxes

Waxes are esters of fatty acids.

In contrast to fats and oils, the fatty acids are not esters of glycerol but of higher primary monovalent alcohols.

Beeswax: It is secreted by young honey bees (Like *Apis cerana indica* Fabricious. Family: Apidae) to construct the honeycomb.

Carnauba wax: It is obtained from the leaves of palm trees [*Copernicia prunifera* (Mill.) H.Moore. Family: Arecaceae] preferably in Brazil.

Candellila wax: It is derived from the leaves of the Candelilla shrub [*Euphorbia antisyphilitica* Zucc. Family *Euphorbiaceae*], which is native to the northern Mexico.

Phospholipids

Phospholipids are present in all animal and plant cells. Commercially, they are isolated from the egg yolk (lecithin) and soybean oil (lecithin) [42], but are also produced from milk fat globular membrane isolated from buttermilk [43]. Lecithin is commercially available at high purity.

J. Others

Polyvinylpyrrolidone (PVP)

It is a synthetic neutral polymer. PVP powder is well soluble in water and organic solvents.

Paraffin

It is a family of linear hydrocarbons and its source is petroleum but synthesis is also possible.

Shellac

It is secreted by the lac insect *Laccifer lacca (Kerria lacca)*, found in the forests of northeast India, Thailand, Bangladesh, Indochina, and China.

Inorganic materials

There are several food-grade inorganic materials, which have been described as being useful for coatings or microencapsulation in food applications. They can be utilized alone

or in combination with other materials. They include tripolyphosphate, silicon oxides, aluminum oxides etc. [40].

Use of nanotechnologies in encapsulation of materials

Different aspects of application of nanotechnology in packaging of food and related materials are discussed in the article of Rai and Bai (2018) [44].

Some important research findings in the field

* Alginate is a polysaccharide extracted from algae composed of various amounts and sequential distribution of b-D-mannuronic (M) and a-L-guluronic acids (G) (block copolymer containing both MM, GG, and irregular sequences of M and G units) that can affect functional properties of alginate as a supporting material [45].

* Resistant starch (Hi maize) and chitosan at concentrations of 1% and 0.4% were added to the microencapsulation of *Lactobacillus acidophilus* in alginate beads by extrusion technique showed good effects [46].

* Emulsification/internal gelation is an encapsulation method showing great potential to confer protection on probiotics that need to be added to foods with an unfavorable environment for their viability. Emulsification/internal ionic gelation associated with the freeze-drying process could be considered feasible technology for the protection, application and controlled release of probiotics for use in foods [47].

* Microencapsulation conferred greater protective effect to *L. acidophilus* as compared to the free cells. However, the coating of pectin microparticles with whey protein did not confer additional protection to probiotics when exposed to simulated gastrointestinal conditions [48].

* Electrospraying was used to microencapsulate *Lactobacillus plantarum* in sodium alginate or in sodium alginate-citric pectin matrixes delivered good result [49].

* Sodium alginate, chitosan and hydroxypropyl methylcellulose (HPMC) were evaluated as co-encapsulants for spray dried *Lactobacillus acidophilus* by assessing their impact on cell viability and physicochemical properties of the dried powders, viability over storage and survival after stimulated digestion. Fibers were added to a

control carrier medium containing whey protein concentrate, D-glucose and maltodextrin. Sodium alginate and HPMC did not affect cell viability but chitosan reduced viable counts in spray dried powders, but showed excellent storage stability. Chitosan also improved survival rates in simulated GI conditions [50].

Encapsulation of proposed bio-medicines

The available technologies and materials used for encapsulation of food or food products are discussed. But to identify effective materials for encapsulation of the novel type of bio-medicines/ other succulent plant part products, research is definitely needed. An added quality of the encapsulation material, the cold tolerance at – 25^0C or even below – 80^0C temperature should be there. The products like Maize powder, or the steamed Rice powder, Wheat powder, Barley, Sago etc. [which are traditionally used in same or other related purposes like in preparation of *Momo, Ice cream cone, Purpeetha* (a food preparation of coconut with molasses covered by wet rice powder and steam boiled together) etc.] should be given importance in such research. The encapsulating materials like combination of collagen and cellulose (used as a cover of sausage casing) etc. should also be studied.

For encapsulation of fruit products, some basic models may be considered.

A model for encapsulation of fruit pulps/ fruit juices/ real fruit ice creams

The pulp of the whole fruit, solidified fruit juices or real fruit ice creams (by keeping them in negative temperatures) may be packed by some edible materials. These may be first covered by some semi-solid or pasty edible material like honey or concentrated sugary sap [like sap of *Borassus flabellifer* L. or *Pho enix sylvestris* (L.) Roxb.] or the concentrated juice of the same fruit which may act as bio-preservative. Then the whole material may be encapsulated by some partially cooked or digested edible material which take a gel like shape and then solidify after cooling (like gelatine, agar, maize flour, arrowroot flour etc.). These may be considered as the outer capsule of the product. One sterile wooden stick may be inserted in it for holding during consumption. Then the product is ready for freezing and storage. One model of such encapsulated product is shown in Fig 3.

Following steps may be followed for encapsulation of succulent fruit pulp/ fruit juice/ real fruit ice-cream

1. Pulp of whole fruit/ fruit juice may be the innermost part. That part may be made frozen before entering to the next step.

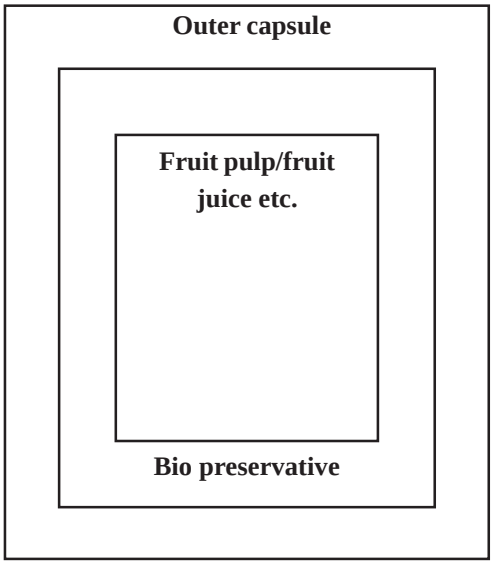

Fig. 3. A model of encapsulation of succulent fruit pulp/ fruit juice/real fruit ice-cream.

2. The juice of the same fruit may be made concentrated previously to use it as the bio preservative, if it can serve the purpose. In such cases, particularly for fruit juices, the whole material will mix together and the bio-preservative will be a part of the liquid fruit juice after reaching a higher temperature during intake of the consumer.
3. In other cases (as for pulp of whole fruit), it will add some extra taste and may add a good organoleptic feeling to the product (as the external edible covering of cocoa found in ice-cream cones) for the consumers.
4. If the concentrated fruit juice of the same fruit cannot serve the purpose for a fruit preparation, then materials like honey, concentrated natural sugary saps of plant origin (as stated before) etc. may be used.
5. It is always better to use any edible material as outer capsule (as discussed before), but non-toxic materials may be used as disposable outer capsule if proper alternative is not found.
6. For real fruit ice creams, same procedure may be applied but the bio-preservative fruit juice may be different from the fruit juice/pulp added with milk /milk product to prepare the innermost mass. There may be some logical choice of fruit juice or sap for this purpose.
7. Fruit juices may be taken after bringing them to the desired temperature.

A model set up for production of bio-healthcare products

A set up for production of bio-healthcare products is shown in Fig. 4.

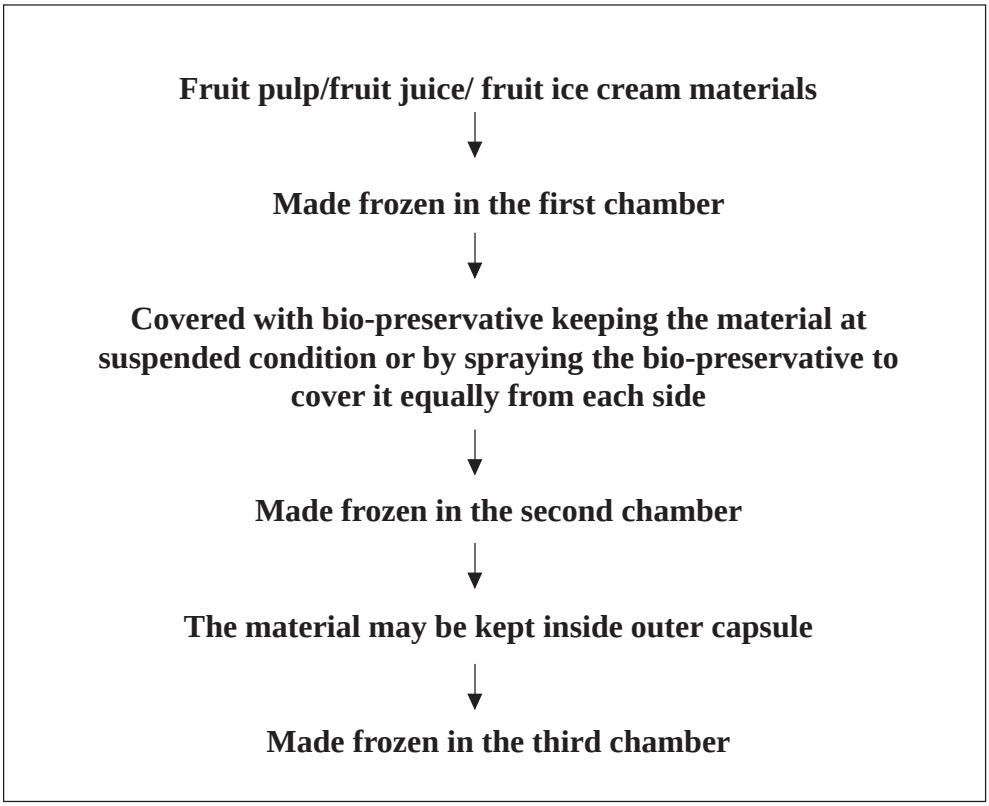

Fig. 4. A model set up for production of bio-healthcare products.

Chapter IX

Determination of expiry, spoilage or decomposition of the bio-products

The oral bio-medicines, healthcare products for local use and the unaltered fruit juices, fruit pulps or fruit ice-creams – all are vulnerable to spoilage. The reason may be ageing, gap in the cold chain or any other previously unpredictable reason/s. There should be one easy detection procedure for the consumer/ end user to identify the condition of the inner products without opening of the packets.

Among the available study reports on that subject, change of color of some added chemicals on the packet due to exposure of the packed materials to any environment other than the scheduled one may be considered as most important.

In practical situations, this may be performed by using some chemical colors on the packets. After exposure to a certain temperature for a certain period of time, the color of these chemicals' change. A color identity is kept surrounding these chemicals. Observing the color of the surrounding area and comparing it with the color of the chemicals, anybody can understand the actual condition of the products kept inside the packets.

Many of such color chemicals are already available. These are available for different ranges of temperature also. These can be effectively used to serve the purpose.

Such coloring materials are commonly used to determine the actual condition of the thermolabile vaccines. In that field, these are called as Vaccine Vial Monitors.

Some important points regarding the whole matter is discussed in this section.

Spoilage of foods: common causes

If food items are kept for a long period of time and not stored properly, they get spoiled and such food items are bad for our health. When food items kept for a long time gets spoil as germs start growing on it. Once the food is spoiled, it cannot be eaten and has to be thrown away. Spoilage is a process in which food items deteriorate to the point in which it is not edible to us [13].

There are various factors which are responsible for food spoilage such as bacteria, yeast, mold; exposure to improper moisture, temperature, light, internal chemical reactions of food ingredients etc. [13].

Signs of food spoilage

Signs of food spoilage include an appearance different from the fresh food or products, such as a change in color, a change in texture, an unpleasant odor or taste etc. [13].

Identification of spoiled foods

Many foods change their color, texture, appearance etc. after spoilage. However, a few reports are available for identification of spoiling of packed foods from outside.

Some research papers and patents are found which targeted the emitted gases of the decomposed/ spoiled food to use them to initiate chemical changes in the chemicals kept in some porous sac. The change of pH and/or color of these chemicals can proof the spoilage. In most of the cases, the name of such chemicals is not disclosed.

Some related study reports:

1. A food package comprising food and a food spoilage indicator disposed therein in contact with said food, said food spoilage indicator consisting essentially of liquid crystals disposed in a carrier of plastic film, at least one portion of which is semi-permeable to gases of the type generated in food spoilage, said liquid crystals being selected from the group consisting of cholesteryl or cholestanyl chloride, cholesteryl or cholestanyl bromide, cholesteryl or cholestanyl erucate, cholesteryl or cholestanyl olelyl carbonate, cholesteryl or cholestanyl erucyl carbonate, and cholesteryl or cholestanyl oleate [51]. The change of color will be the indicator of spoilage.

2. A colorimetric mixed-pH dye-based indicator with potential for the development of intelligent packaging, as a “chemical barcode” for real-time monitoring of skinless chicken breast spoilage was studied. Investigation was also established the relationship between the numbers of microorganisms and the amount of volatile compounds. This on-package indicator contains two groups of pH-sensitive dyes, one of which is a mixture of bromothymol blue and methyl red, while the other is a mixture of bromothymol blue, bromocresol green and phenol red. Carbon dioxide (CO_2) was used as a spoilage metabolite because the degree of spoilage was related to the amount of increased CO_2, and which was more than the level of total volatile basic nitrogen (TVB-N) during the storage period [52].

Vaccine Vial Monitors

A vaccine vial monitor (VVM) is a label containing a heat sensitive material which is placed on a vaccine vial to register cumulative heat exposure over time. The combined effects of time and temperature cause the inner square of the VVM to darken, gradually

and irreversibly. A direct relationship exists between the rate of colour change and temperature [53].

Vaccine vial monitors are used generally to warn health care workers if a vaccine was damaged by heat. The darkened colour of the monitor chemical indicates that the vaccine is no longer effective and should not be used [54].

Chemicals used in Vaccine Vial Monitors

During 1979, World Health Organization (W.H.O.) conceived the concept of Vaccine Vial Monitor, where p- toluene sulfonate was used as the chemical for the purpose. Research, trial and discussion was going on and during 1988, a new type of chemical, di acetylene polymers came in the field with better performance [55]. But the actual chemicals used presently in VVMs are not disclosed.

A tentative chemical reaction of Vaccine Vial Monitors is displayed in Fig. 5.

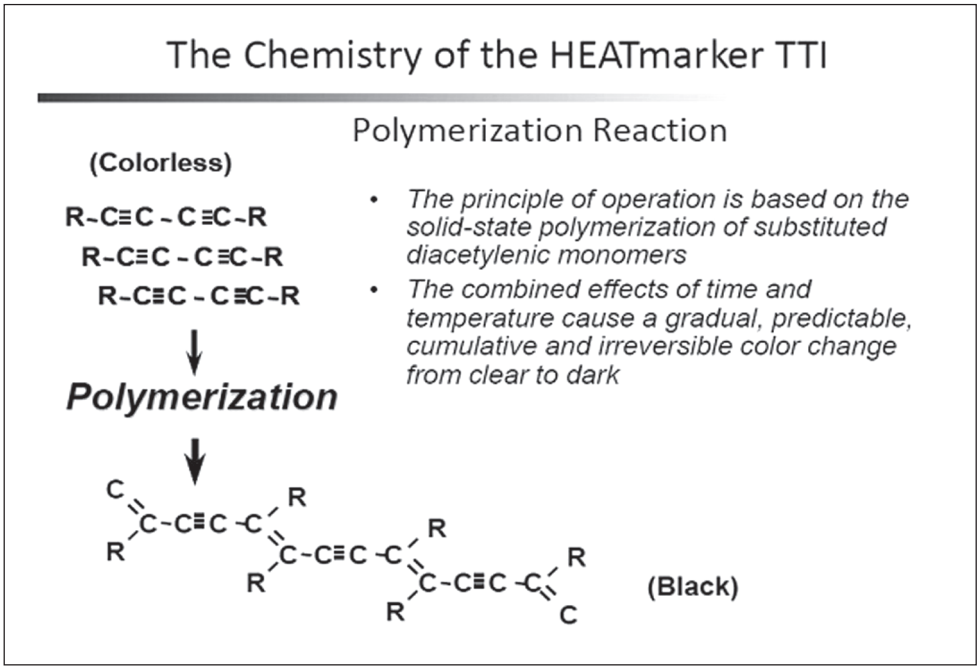

Fig. 5. The chemistry of Vaccine Vial Monitors (di-acetylenic monomers) [56].

Reaction rate of Vaccine Vial Monitors

The reaction rate of different Vaccine Vial Monitors as per their heat-stability is shown in Table 8.

Table 8. Reaction rate of Vaccine Vial Monitors by category of heat stability [57].

Category (Vaccines)	No. of days to end point at 37 ^{0}C	No. of days to end point at 25 ^{0}C	Time to end point at 5 ^{0}C
VVM 30 (High stability)	30	193	More than 4 Years
VVM 14 (Medium stability)	14	90	More than 3 Years
VVM 7 (Moderate stability)	07	45	More than 2 Years
VVM 2 (Least stability)	2	Not Available	225 days

How VVM is designed?

A circle is made and a square is drawn in its central. The square is filled with the VVM chemicals. Outside of that square, the rest area of the circle is filled by blackish colour. The density of the colour of central square is actually the indicator of the condition of the VVM chemicals. It can equally denote the condition of the vaccine kept in the vial.

The colour density of the indicator is:

a) At the start point of the vaccine storage: Square colour is lighter than the rest portion of the circle.

b) At the end point of the vaccine during storage (spoilage of vaccine): Square colour matches the rest portion of the circle.

c) At the end point of the vaccine exceeded during storage (vaccine already spoiled): Square colour is darker rest portion of the circle [57].

Integrity of the Vaccine Vial Monitors

The integrity of VVMs depends on the presentation of the vaccine, *i.e.* liquid vaccines, freeze dried vaccines etc.

For liquid vaccines

The VVM will be permanently attached to the vaccine vial, even after the vial has been opened and must remain readily observable before, after and during use. Prior to opening, the VVM should not be removable: it should resist removal from the vaccine vial as much as a label meeting current requirement.

For freeze dried vaccines

The VVM will be attached to the vaccine vial or ampoule and must remain readily observable until the vial or ampoule is opened but not observable after opening. Prior to opening, the VVM should not be removable: it should resist removal from the vaccine vial as much as a label meeting current requirement [57].

Electronic time–temperature indicator (eTTI): another monitoring system

Electronic time–temperature indicator (eTTI) monitors can be programmed to exactly follow the stability characteristics of vaccines with a high degree of realism. The monitors have a visual output, enabling vaccine status to be assessed at a glance, and can also output more detailed statistical data. When packaged with vaccine vials in groups of about 10 vials per box, the eTTI can remain with a vaccine throughout most of the vaccine's lifetime. The monitors can detect essentially all cold-chain breaks, and can detect issues, such as inadvertent freezing, that are presently not detected by other vaccine stability monitors such as Vaccine Vial Monitors (VVM) [58].

Requirement of legislative control on preparation and marketing of bio-medicines and other bio-products

All the bio-medicines and other bio-products are prone to lose their efficacy or even conversion to some toxic materials if proper quality control measures are not taken during preparation of the products and if any gap in maintenance of proper cold chain of the products is there. As a part of business competition or any other bad intension, these may be added with some toxic chemicals, some slow poisoning materials or may be adulterated with some health hazardous chemicals. To keep production and marketing costs at a very low level to market the products at a very low cost, there may be different compromises with the desired or directed measures. Such products may be sold in the market without following strict measures of manufacturing, transport and storage of the products.

To control all such malpractices, there should be some strong legislative control on production, transportation, storage and marketing of these products. As the proposed healthcare system is a new one, so previously formulated rules and regulations may not cover all the related aspects. Specific guidelines should be imposed from the end of the competent authorities before giving any permission of manufacture and marketing of such products.

Chapter X

Preparation of unaltered fruit juices, fruit pulps or real fruit ice-creams

The people, mainly the children and the persons of younger generations, are fed some synthetic chemicals in the name of fruit juice/ fruit pulp/ soft drinks/ lemon drinks/ fruit ice cream etc. just to increase the profit of some companies. Many of such products are practically a cocktail of some chemicals and some are added a little fruit juice or fruit pulp along with a lot of chemicals. So, people are consuming a lot of chemicals daily from childhood in the name of food without knowing the actual fact. This condition can easily be changed by supplying original fruit juice, fruit pulp, fruit ice creams and such products in the market.

The fruits or other succulent plant parts having the quality for utilization as some pulps or drinks are available in some particular area of all countries due to seasonal production at these areas. The farmers do not get actual value of these products due to such seasonal production, high transport cost to the consumers, pressure of middlemen and for huge availability in the market at a time. Distress sale of such produces by the farmers is a very common phenomenon due to these reasons.

This condition can be changed if the proposed novel type of bio-products is produced near the source of agricultural production of the original item. As for example, the pine apple sold in the markets of Jalpaiguri district of West Bengal, India at the rate of Rs. 5/ piece during production period. A piece of very good quality mango having weight of over 300 grams is also sold at the same price in the Malda district of the same state of India!

Some useful fruits are not eaten by most of the people in India due to their presentation at a dirty situation in the market. Ripened Jackfruit is one such example in India. But it may be considered as a famous fruit drink if collected, prepared and presented properly.

Though advised by physicians and healthcare workers to take at least a fruit per day, most of the people of younger generations (our future generations) are not interested to eat fruits directly. Better, they take chemical drinks with added flavor of these fruits! These people may be attracted to take original fruit/ fruit juice or other related products.

In Table 9, some of such fruits and edible plant extracts are listed which may be prepared and marketed within a very short period just after some quality control tests. Different parameters related with extraction of juice, preparation of the product, use of bio-preservatives (if any), packaging, presentation, storage and transportation to the consumers under cold chain are already discussed. The local names in Bengali and Hindi are added along with the English name for easy identification of the plant. But some fruits are not native to India and so their local names are not available.

The following additional points are important in this regard.

* Small amount presentation may be performed as children or others may take two or more separate preparations one after another in a single day as per their choice/ requirements.

* More than one fruit juice may be mixed, if found useful and without any harmful effect on health.

* May be added with milk or milk products taking from direct source and not added with preservatives to market them as the best alternative of ice creams.

* As the fruit juice/ real fruit ice creams are are expected to have some very good additional effects on our health, these may be selectively given to the children at different days/ different times of a day to supply adequate and proper nutrition. Deficiency of vitamins and minerals of particular type may also be checked by selective feeding of these food products along with some bio-medicines.

Table 9. Proposal for use of fruits and some succulent plant parts/ extracts for use as unaltered fruit juices, fruit pulps, beverages or real fruit ice-creams.

Plant	Common name (B= Bengali H= Hindi E= English)	Part for use	Additional effect/s	Study reports (Quantity calculation shown: Carbohydrate, Protein, Fat - gm/ 100 gm, Vitamins and minerals - mg/100 gm).
Actinidia deliciosa (A.Chev.) C.F.Liang & A.R.Ferguson Family: Actinidiaceae	B. Kiwi H. Kiwi E. Kiwi fruit	Pulp of ripe fruit	Contain Vitamin K along with other important nutrients.	Carbohydrates (14.66), Protein (1.14), Fat (0.52), Vit. C (92.7), Vit. K (40.3), Vit. E (1.46), Vit. B9 (Folate, 25 ug). Calcium (34), Phosphorus (34), Potassium (312), Iron (0.31) and many other important vitamins and minerals at small quantities [59].
Aegle marmelos (L.) Corrêa Family: Rutaceae	B. Bail H. Bael E.Bengal quince	Pulp of ripe fruit	Contain Good amount of carbohydrates, vitamins and minerals. Act as mild laxative.	Carbohydrate (31.8), Protein (1.8), Fat (0.3), Vit. A (55 ug), Vit. B2 (1.2), Calcium (85), Phosphorus (31.8), Iron (0.6) [60]. Contain many important phytochemicals beneficial to health [61].
Ananas comosus (L.) Merr. Family: Bromeliaceae	B. Anaras H. Anaras E. Pine apple	Fruit	Supply Vitamin A, Vitamin C and Manganese	Carbohydrates (13.12), Protein (0.54), Fat (0.12), Vit. A (58 IU), Vit. B6 (0.112), Vit. B5 (0.213), Vit. C (47.8), Calcium (13), Magnesium (12), Potassium (109), Phosphorus (8), Iron (0.29) etc. [62]

Contd...

Plant	Common name (B= Bengali H= Hindi E= English)	Part for use	Additional effect/s	Study reports (Quantity calculation shown: Carbohydrate, Protein, Fat - gm/ 100 gm, Vitamins and minerals - mg/100 gm).
Artocarpus heterophyllus Lam. Family: Moraceae	B. Kanthal H. Kanthal E. Jack fruit	Pulp of ripe fruit	Contain good amount of Vitamin B_6, Vitamin C and Potassium.	Carbohydrates (23.25), Protein (1.72), Fat (0.64), Vit. C (13.7), Vit. B6 (0.329), Vit. B1 (0.105), Vit. E (0.34). Calcium (24), Phosphorus (21), Potassium (448), Iron (0.23) and many other important vitamins and minerals at small quantities [63].
Averrhoa carambola L. Family: Oxalidaceae	B. Kamranga H. Karmal E. Star fruit	Pulp of ripe/ semi-ripe fruit	Contain high Vitamin C and many vitamins and minerals.	Carbohydrates (6.73), Protein (1.04), Fat (0.33), Vit. C (34.4) and almost all vitamins and minerals at minute quantities [64].
Borassus flabellifer L. Family: Arecaceae	B. Tal H. Tal/Tad E. Doub Palm, Ice Apple	The sugary sap from the young inflores-cence	Good source of Vitamin B complex.	The fresh sap is a good source of Vit. B-complex [65].
Borassus flabellifer L. Family: Arecaceae	B. Tal H. Tal/Tad E. Doub Palm, Ice Apple	Ripe fruit	Good source of Vitamin A and Vitamin C.	The fresh pulp is reportedly rich in Vit. A and Vit. C [65].
Carica papaya L. Family: Caricaceae	B. Papey H. Popita E. Papaya	Pulp of ripe fruit	Contain Vitamin C, Folate, Vitamin A, Calcium, Magnesium, Potassium etc.	Carbohydrates (10.82), Protein (0.47), Fat (0.26), Vit. C (62), Vit. A (47 ug), Vit. B5 (0.191), Vit. B9 (Folate, 38 ug), Vit. E (0.30). Calcium (20), Phosphorus (10), Potassium (182), Iron (0.25) and many other important vitamins and minerals at small quantities [66].

Contd...

Plant	Common name (B= Bengali H= Hindi E= English)	Part for use	Additional effect/s	Study reports (Quantity calculation shown: Carbohydrate, Protein, Fat - gm/ 100 gm, Vitamins and minerals - mg/100 gm).
Citrus × *sinensis* (L.) Osbeck Family: Rutaceae	B. Kamla Lebu H. Santra E. Orange	Pulp or Juice of ripe fruit	Most delicious citrus fruit, contain Carbohydrate, Vitamin C and many other Vitamins, Minerals.	Carbohydrates (11.75), Protein (0.94), Fat (0.12), Vit. C (53.2), Vit. A (11 ug), Vit. B9 (Folate, 30 ug). Calcium (40), Phosphorus (14), Potassium (181) and many other important vitamins and minerals at small quantities [67].
Fragaria × *ananassa* Duchesne Family: Rosaceae	B. Strawberry H. Strawberry E. Strawberry	Pulp of the fruit	Contain Vitamin C, Potassium, Manganese along with other important nutrients	Carbohydrates (7.68), Protein (1.67), Fat (1.17), Vit. C (10.2), Vit. K (16.4 ug), Vit. B9 (Folate, 38 ug). Calcium (10), Phosphorus (36), Potassium (236), Manganese (0.386) and many other important vitamins and minerals at small quantities [68].
Malus domestica Borkh. Family: Rosaceae	B. Apple H. Seb E. Apple	Pulp of ripe fruit, excluding seeds	Contain Carbohydrates, and many other important nutrients.	Carbohydrates (13.81), Protein (0.26), Fat (0.17), Vit. C (4.6), Vit. B6 (0.041), Calcium (6), Phosphorus (11), Potassium (107), Iron (0.12) and many other important vitamins and minerals at small quantities [69].
Mangifera indica L. Family:Anacardiaceae	B. Aam H. Aam E. Mango	Pulp of ripe fruit	Most tasty fruit; contain Carbohydrate and many Vitamins, Minerals.	Carbohydrates (15), Protein (0.82), Fat (0.58), Vit. C (36.4), Vit. A (54 ug), Vit. B6 (0.119), Vit. B9 (Folate, 43 ug). Calcium (11), Phosphorus (14), Potassium (168), Iron (0.16) and many other important vitamins and minerals at small quantities [70].

Contd...

Plant	Common name (B= Bengali H= Hindi E= English)	Part for use	Additional effect/s	Study reports (Quantity calculation shown: Carbohydrate, Protein, Fat - gm/ 100 gm, Vitamins and minerals - mg/100 gm).
Manilkara zapota (L.) P.Royen. Family: Sapotaceae	B. Safeda H. Chikoo E. Sapodilla	Pulp of ripe fruit	Contain high Carbohydrate and Vitamin C and many vitamins and minerals.	Carbohydrates (19.96%), Protein (0.44%), Fat (1.1%), Vit. C (14.7) and many other important vitamins and minerals at small quantities [71].
Phoenix sylvestris (L.) Roxb. Family: Arecaceae	B. Khejur H. Khajur E. Indian date	Fresh sap collected from trunk, directly or concentrated	High sucrose, contain potassium and other minerals.	Sap contain high amount of sugar (mainly Sucrose) and Potassium (65.28), Sodium (2.85), Magnesium (0.54), Zinc (0.37), Iron (0.27) etc. [72].
Phoenix dactylifera L. Family: Arecaceae	B. Khejur H. Khajur E. Date palm	Fruit pulp	High Carbohydrate, Potassium, Calcium, Vitamin B6, Vitamin B5 and many other important nutrients.	Carbohydrates (75.03), Protein (2.45), Fat (0.39), Vit. B6 (0.165), Vit. B5 (0.6589), Calcium (39), Magnesium (43), Potassium (656), Phosphorus (62), Iron (1.02) etc. [73].
Prunus domestica L. Family: Rosaceae	B. Alu Bhokhra H. Alu Bukhara E. Plum	Pulp of the ripe fruit	Contain Vitamin A, Vitamin C, calcium, Potassium, along with other important nutrients	Carbohydrates (11.42), Protein (0.7), Fat (0.28), Vit. A (17), Vit. C (9.5), Vit. K (6.4 ug), Vit. B9 (Folate, 5 ug). Calcium (6), Phosphorus (16), Potassium (157), and many other important vitamins and minerals at small quantities [74].
Psidium guajava L. Family: Myrtaceae	B. Peyara H. Amrudh E. Guava	Pulp of ripe fruit, excluding seeds	Contain Carbohydrates, Vitamin C and many other important nutrients.	Carbohydrates (14.32), Protein (2.55), Fat (0.95), Vit. C (228.3), Vit. A (31 ug), Vit. B3 (1.084), Vit. B9 (Folate, 49 ug). Calcium (18),

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Plant	Common name (B= Bengali H= Hindi E= English)	Part for use	Additional effect/s	Study reports (Quantity calculation shown: Carbohydrate, Protein, Fat - gm/ 100 gm, Vitamins and minerals - mg/100 gm).
				Phosphorus (40), Potassium (417), Iron (0.26) and many other important vitamins and minerals at small quantities [75].
Punica granatum L. Family: Lythraceae	B. Bedana H. Anar E. Pomegranate	Juice of the ripe fruit	Contain Carbohydrate, Vitamin C and Potassium along with other important nutrients	Carbohydrates (18.7), Protein (0.67), Fat (030), Vit. C (58.8), Vit. K (2.2 ug), Vit. B9 (Folate, 24 ug). Calcium (16), Phosphorus (24), Potassium (154) and many other important vitamins and minerals at small quantities [76].
Rubus fruticosus L. [Species aggregate] Family: Rosaceae	B. — H. — E. Blackberry	Pulp of the fruit	Contain Vitamin A, Vitamin C, calcium, Potassium, along with other important nutrients	Carbohydrates (9.61), Protein (1.39), Fat (0.16), Vit. A (214 IU), Vit. C (21.0), Vit. K (19.8 ug), Vit. B9 (Folate, 25 ug). Calcium (29), Phosphorus (22), Potassium (162), and many other important vitamins and minerals at small quantities [77].
Vitis vinifera L. Family: Vitaceae	B. Angur H. Angur E. Grape	Juice of the fruit	Contain high Fructose, Vitamin C and Potassium, along with other important nutrients	Carbohydrates (18.1), Protein (0.72), Fat (0.49), Vit. C (3.2), Vit. K (14.6 ug), Vit. E (0.19). Calcium (10), Phosphorus (20), Potassium (191), and many other important vitamins and minerals at small quantities [78].

Chapter XI

Preparation of bio-products for skin care and hair care

Availability of beautifully packed products for skin care, hair care, medicine for acne and summer itches, medicine of baldness etc. are plenty in each and every country and the total annual turnover in such marketing is also definitely very high. Like the healthcare medicines, many so called 'Herbal' products are sold in these areas also. Such products also generally contain many chemicals of basically synthetic origin. Some synthetic chemicals and/or some modern medicines are added with some 'natural' medicine/s and also sold as herbal medicines. These so called 'natural' medicines are actually some 'nature-identical' chemicals in many cases. Many such 'herbal' cosmetics are also sold at some very high price in the market depending mainly on the advertisements. The following statement of Hella *et al*. (2018) can inform us the actual study performed on possible health impacts of these chemicals before marketing them.

"Many points are discussed in many articles regarding various aspect of research on preparation of cosmetics, but little importance is given for discussion on toxicity study of the added chemicals in cosmetics" [79].

In Table 10, some formulation of bio- products for skin care and hair care are added to initiate marketing of such bio-products in this field also. Most of these or alike products are used by a section of people from a long back, so chance of getting any toxic effect from these products is very less.

Like the bio-medicines and other oral bio-products, these skin care bio-products are supposed to be prepared by use of succulent plant parts, their juices or their oils. Separate packaging of each item until the time of use is the best option for these products also.

Table 10. Plants proposed for use as some bio-medicines for skin care and hair care[*].

Scientific name	Name (B= Bengali H= Hindi E= English)	Preparation	Purpose	Use/ Combinational use#
Curcuma longa L. Family: Zingiberaceae	B: Halud H: Haldi E: Turmeric	Succulent root paste for local application	To keep the skin disease free as well as make the skin glossy and fair.	A pasty mixture is to be prepared after mixing of root paste of *Curcuma longa* and matured leaf- paste of *Azadirachta indica* and oil of *Olea europaea* or *Brassica juncea* just before use. That is used by mild skin rubbing one hour before bathing @ once at each week[$]
Azadirachta indica A. Juss. Family: Meliaceae	B: Neem H: Neem E: Indian lilac	Matured leaf- paste for local application		
Olea europaea L. Family: Oleaceae	B: Olive tael H: Jetun E: Olive oil	Base of others		
Brassica juncea (L.) Czern. Family: Brassicaceae	B. Sorse tail H. Sarso ka tail E.Mustard oil	Base of others		
Aloe vera (L.) Burm.f. Family: Asphodelaceae	B. Ghreet Kumari H. Ghreetakumari E. Aloe	Pulp for local application	To keep the skin glossy, fair and disease free.	Leaf gel for skin care[$]
Cucumis sativus L. Family: Cucurbitaceae	B. Sasha H. Khira E. Cucumber	Fruit paste		Paste of *Cucumis sativus*, *Daucus carota* and Yogurt are to be mixed together before use on face with dry skin. For wet skin, Yogurt may be replaced by Honey. Regular oral intake of *Daucus carota* or its paste should also accompany the treatment.
Daucus carota subsp. sativus (Hoffm.) Schübl. & G. Martens Family: Apiaceae	B. Gajor H. Gajor E. Carrot	Root paste for oral and/ or local use		

Contd...

Scientific name	Name (B= Bengali H= Hindi E= English)	Prepar-ation	Purpose	Use/ Combinational use#
Yogurt	B. Dahi H. Dahi E. Yogurt	As a base as well as an active substance		
Honey	B. Madhu H. Shahad E. Honey	As a base as well as an active substance		
Coccinia grandis (L.) Voigt. [Wild variety] Family: Cucurbitaceae	B. Telakucha H. Kadava Kunduru E. ivy gourd	Leaf paste for local application	Used on palms and skin in diseases like scabies	The paste is to be applied three times a day and to be kept for at least one hour.
Andrographes paniculata Nees. Family: Acanthaceae	B.Kalmegh H. Kirayat E.Green chirayta	Leaf paste for oral use	To cure the persons suffering from skin diseases chronically	Leaf paste capsule or dried leaf paste made from 3-4 grams of leaves is to be taken once at every week orally.
Azadirachta indica A. Juss. Family: Meliaceae	B: Neem H: Neem E: Indian lilac	Tender leaf paste for oral use	To destroy the root of starting of skin diseases, boosting of immunity and strengthening of liver.	The tender leaves are available only at the spring season. People of some rural areas of India traditionally take them after mixing with curry or just after a little frying. The leaf paste may be used in the said purposes.
Curcuma longa L. Family: Zingiberaceae	B: Halud H: Haldi E: Turmeric	Succulent root paste for oral intake	To cure and control pimples of face and to keep skin glossy, free from any infection by acting on liver and as an overall immunostimulant.	Root paste is to be taken orally at morning. No food is to be taken for one hour.

Contd...

Scientific name	Name (B= Bengali H= Hindi E= English)	Preparation	Purpose	Use/ Combinational use#
Litsea glutinosa (Lour.) C.B.Rob. Family: Lauraceae	B: Piplas H: Maidalakri E: Soft bollygum	Leaf mucilage for oral use	It can stop initiation of summer itches; can strengthen the weak digestive system by 'cooling' the system.	Oral intake of mucilage throughout the summer season at the morning before taking any food may be the schedule.
Ocimum sanctum L. Family: Lamiaceae	B: Tulsi H: Tulasi E: Holy Basil	Leaf paste		Leaf paste of *Ocimum sanctum* L. and fruit paste of *Piper longum* L. mixed and applied on scalp to control alopecia.
Piper longum L. Family: Piperaceae	B: Pipul H: Pipli E:Indian long pepper	Fruit paste		
Eclipta prostrata (L.) L. *Eclipta alba* (L.) Hassk. Family: Asteraceae	B: Keshut H: Bhringaraj E: False daisy	Leaf extract	Hair tonic	Can reduce hair loss, strengthen hair root. Improves hair growth, prevents hair fall, and treat premature greying of hair.
Sapindus mukorossi Gaertn. Family: Sapindaceae	B: Ritha H: Reetha E: Indian soapberry	Fruit dust	Herbal shampoo along with removal of lice and total hair care.	May be mixed with worm water before use as a non-toxic total hair care agent.
Acacia concinna (Willd.) DC. Family: Fabaceae	B: Sikakai H: Sikakai E:Soap nut acacia	Fruit dust	Herbal shampoo along with anti-dandruff property and also total hair care.	

*A proposal for prevention of diseases is discussed. The dosing should be calculated by following conventional techniques [5, 6, 7]. Then validation of the schedules given may be performed as per standard guidelines.
#Oral medicines may be taken preferably at morning. Food and drinks may be avoided for at least next half an hour.
$Skin allergy testing of ingredients should be a pre-requisite.

Chapter XII

Projection for a pilot study for marketing of a few succulent bio-medicines

In the first volume of this book, list of more than 1000 plants are attached with their previous reports of having efficacy to control or cure infectious diseases. In this chapter, sixty one (61) plants are described to start marketing oriented study for the important purposes like control/ cure/ potentiation of body efficacy for diabetes, high blood pressure, heart diseases, reduction of blood cholesterol, immune-stimulation, complications of Dengue fever, urinary tract disorders, cancers, asthma, pneumonia bronchitis, insomnia, dementia, increase of memory power, osteoporosis, anaemia, excessive menstrual bleeding, restoration of sexual power, jaundice, kidney and liver protection, irritable bowel syndrome, stomach ulcer, dysentery and bloody enteritis, constipation, hemorrhoids and piles, eczema and other skin problems etc. A pilot project may be prepared covering these plants for study of their efficacy, dose and toxicity to market them following the procedures described in the book (Volume I and Volume II) [Table 11].

Table 11. List of plants to initiate a pilot study for validation of medicinal efficacy and preparation of a few succulent bio-medicines from them.

Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Abutilon indicum (Link) Sweet. *Sida indica* L. Family: Malvaceae	B: Potari H: Kanghi E: Indian mallow	The whole plant paste/ extract may be used as aphrodisiac agent and curative agent of defects of gynecological system of girls [80].	Various parts of the plant are used as a demulcent, aphrodisiac, laxative, diuretic, sedative, astringent, expectorant, tonic, anti-inflammatory, anthelmintic, and analgesic and to treat leprosy, ulcers, headaches, gonorrhea, and bladder infection [81]. A self medicine of Chimpanzee.

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Acacia leucophloea (Roxb.) Willd. *Mimosa leucophloea* Roxb. *Vachellia leucophloea* (Roxb.) Maslin, Seigler & Ebinger Family: Fabaceae	B: Sada Babul H: Reonja E: White Barked Acacia	Bark extract as preventive and curative of microbial infections [82].	The bark extracts used as astringent, bitter, thermogenic, styptic, preventive of infections, anthelmintic, vulnerary, demulcent, expectorant, antipyretic, antidote for snake bites and in the treatment of bronchitis, cough, vomiting, wounds, ulcers, diarrhea, dysentery, internal and external hemorrhages, dental caries, stomatitis, intermittent fevers and skin diseases [83].
Achyranthes aspera L. Family: Amaranthaceae	B: Apang, H: Laljiri/ chirchiri E: Prickly chaff flower	Root paste in hemorrhoids and piles [84].	Used in wound healing [85], root ointment used in boils, abscesses [86].
Acalypha indica L. *Ricinocarpus indicus* (L.) Kuntze. Family: Euphorbiaceae	B: Muktajhuri H: Kuppi E: Indian Acalypha	Root paste in lung problems like asthma, pneumonia [87].	It also has significant antibacterial and antifungal activities, both against human and plant pathogens [87]. Used in cutaneous problems [88]; leaf used in ulcer [89].
Acanthospermum hispidum (DC) A Chev. Family: Asteraceae	B: Kanta Gokhuru H: Gokhuru E: Bristly Starbur	Juice/oil as immune-stimulant against infections (anti-bacterial antifungal, anti-parasitic) [90].	Oil antibacterial, antifungal [88]; whole plant in skin diseases [91]; Used in Brazilian folk medicine for the treatment of various ailments including diarrhea, skin diseases, blennorrhagia, dyspepsia, parasitic worms and malaria [90].
Adhatoda vasica Nees. *Justicia adhatoda* L. Family: Acanthaceae	B: Basaka H: Arus,Vasaka E: Malabar nut	Leaf juice to be used as an expectorant, stimulant to respiratory system, an antispasmodic, to treat asthma, chronic bronchitis and other respiratory conditions [92].	Asthma, bronchitis, germ killer, protective for pox infection [27]. It is recommended for making sputum more fluid and for the treatment of cough, asthma and bleeding piles, and it can be used for both adults and children for a long period [93].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Aegle marmelos (L.) Corrêa Family: Rutaceae	B: Bail H: Bel E: Bengal quince	Pulp of ripe fruit in habitual constipation [4].	Used to cure diseases like diabetes, high cholesterol, peptic ulcer, inflammation, diarrhea and dysentery, constipation, respiratory infection. The fruit juice has anticancer, cardio protective, antibacterial, antifungal, radio protective, antipyretic, analgesic, antioxidant, antiviral, anthelmintic and anti-inflammatory, hepatoprotective, wound healing properties. The ripe fruit juice is aromatic, has cooling and laxative effects, and arrests secretion or bleeding [61].
Aframomum melegueta K. Schum. Family: Zingiberaceae	B: —- H: —- E:Grains of paradise	Seed paste for protection from infectious diseases [94], as well as from inflammation and heart diseases [95].	Seed of the plant contain strong anti-inflammatory property and that can render protection of Gorillas from heart disease [95].
Allium sativum L. Family: Amaryllidaceae	B: Ek Koshi Rosun H: Qua Losun E: Single-clove Garlic	Bulb paste to be used for anti-inflammatory, immuno-modulation, anti-microbial as well as cardioprotective and anti-carcinogenic activity [96].	Bulb in respiratory infections, Tuberculosis, duodenal ulcer, skin problems [88].
Ananas comosus (L.) Merr. Family: Bromeliaceae	B. Anaras H. Anaras E. Pine apple	Juice of the soft base of the leaves for use as dewormer and as anti-amoebiasis [97, 98]	Juice of the leaves consumed for hiccoughs, vermifuge, and as purgative [97]; leaves used as anthelmintic, cholagogue; fresh juice taken to treat hiccough and constipation. kill parasitic amoebas, and expel worms [98].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Andrographes paniculata Nees. Family: Acanthaceae	B: Kalmegh H: Kirayat E: Green Chirayta.	Leaf paste as a tonic for digestive system [99] and protective of general infections [100].	Used for treatment of influenza, dysentery, dyspepsia, malaria, cancer [101]; For treating sore throat, flu, and upper respiratory tract infections [100].
Aspilia mossambicensis (Oliv.) Wild. Family: Asteraceae	B: — H: — E: Aspila	Leaf for external use on skin infections [102].	The plant has been used by traditional healers to treat skin diseases, wounds, gonorrhea, abdominal pain, respiratory problems and malaria [102]. Used by chimpanzees as oral medicine [103].
Ayapana triplinervis (M. Vahl) R. King & H.R. *Eupatorium ayapana* Vent. *Eupatorium triplinerve* M.Vahl Family: Asteraceae	B: Ayapan H: Ayapan E: Ayapana tea	Leaf juice as oral medicine for dysentery and bloody enteritis [104].	Decoction of leaves is haemostatic [88]. Decoction of leaves applied externally on face to cure Acne (pimples of face) [105]; decoction of plant is used as stimulant, tonic and diaphoretic. Decoction of leaves has haemostatic properties. Aqueous extract of dried leaves and shoots have cardiac stimulating properties [85].
Bacopa monnieri (L.) Pennell. *Bramia monnieri* (L.) Pennell *Gratiola monnieria* L. *Herpestes monnieria* (L.) Kunth Family: Plantaginaceae	B: Bramhi H: Brahmi E: Thyme-leafed gratiola	Paste or juice of the plant to be used for restoration and increase of memory power [106].	It decreases the rate of forgetting of newly acquired information, and restore the power of tasks assessing attention, verbal and visual short-term memory and the retrieval of pre-experimental knowledge [106]; it can be used in Alzheimer's disease, to improving memory, reduce anxiety, and in attention deficit-hyperactivity disorder (ADHD) [107].
Cajanus indicus Speng. Family: Fabaceae	B: Arahar H: Arahar E: Pigeon Pea	Juice of succulent leaves to feed jaundice patients and to malnourished children [4].	Leaf juice in jaundice, cough, hemorrhoids, stomatitis; leaf and root juice in diabetes [27].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Carica papaya L. Family: Caricaceae	B: Pepey H: Papita E: Papaya	Succulent leaf juice in Dengue fever and for patients having problems of reduction of platelets in blood [108, 109].	The fruit juice and leaf extract have been demonstrated to have a wide variety of properties including anticancer, antioxidative, anti-inflammatory, anti-bacterial, nephro-protective, hepatoprotective, hypoglycemic and hypolipidemic effects, and anti-sickling effect in sickle cell disease. The ripe fruit has been used against ringworm, whereas the green fruit has been used to lower blood pressure, as an aphrodisiac and to induce abortion [110].
Catharanthus roseus (L.) G.Don Family: Apocynaceae	B: Nayantara H: Sadabahar E: Cayenne Jasmine	Succulent extract of matured leaves in diabetes [4]. Stem and leaf juice to treat cancers [111].	Anti-tumor, anti-diabetic, antimicrobial, anti-oxidant and anti-mutagenic [111]. The anticancer alkaloids Vinblastine and Vincristine are derived from stem and leaf. Vinblastine is used experimentally for treatment of neoplasms and is recommended for Hodgkin's disease, chorio-carcinoma. Vincristine is used for leukemia in children [111].
Centella asiatica (L.) Urb. Family: Apiaceae	B: Thankuni H: Mandukaparni E: Indian Pennywort	Leaf extract to fed weak children for immuno-stimulation [4].	Leaf tonic and diuretic, used in Leprosy [88]; in wounds and acne [27].
Cinnamomum verum J.Presl *Cinnamomum zeylanicum* Blume *Camphorina cinnamomum* (L.) Farw. Family: Lauraceae	B: Daruchini H: Dalchini E: Cinnamon	Powder of dried inner part of bark is to be used as a preventive medicine for Diabetes and increase of Cholesterol [112].	It is prescribed for soothing problems of the stomach, urinary tract and diabetes. It is also given to patients who suffer from cold and flu as well [113]; also, in gynecological problems [114].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Citrus maxima Merr. Family: Rutaceae	B. Batabi lebu H.Batawi - lebu E. Pomelo	Ripe fruit pulp of red color/ its extract can be used in all kinds of liver problems including jaundice. It is also considered as nutritive and refrigerant [88].	Used in treatment of cough, fever, gastric disorder [115]. Fruits are rich in Vitamin C. It has been used as sedative in nervous affections, convulsive cough and in the treatment of hemorrhagic diseases and epilepsy [116]. The fruits contain high amount of polyphenolic compound like hesperidin, naringin, caffeic acid, p-coumaric acid, ferulic acid and vanillic acid [117].
Costus igneus N.E.Br. *Chamaecostus cuspidatus* (Nees & Mart.) C.Specht & D.W.Stev. Family: Costaceae	B. Piasal H. Banda/ Bija-sal E. Fiery costus, Spiral flag, Insulin plant	Leaf juice to control and treat diabetes [118].	The leaf contains compound to effect as hypoglycemic, hypolipidemic, antioxidant, anti-urolithiatic, antiproliferative, anti-inflammatory, prevent learning and memory deficit [118].
Cyperus rotundus L. Family: Cyperaceae	B: Muthaghas H: Koreti-jar E: Nut Grass	Paste/extract of rhizome as a curing agent for habitual flatulence and constipation [119].	In Chinese pharmacopoeia, it was described as an agent to regulate circulation, normalize menstruation, and relieve pain. In Sudan the tubers are used in stomach disorders and bowel irritation, dyspepsia, diarrhea, dysentery, ascites, vomiting, cholera, fevers and as anthelmintic [120].
Daucus carota L. /Subsp. Sativus Family: Apiaceae	B: Gajar H: Gajor E: Carrot	Root paste or juice as immune-stimulant, for protection of skin and increase glossiness [4].	Root diuretic, stimulant [88].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Emblica officinalis Gaertn. *Phyllanthus emblica* L. Family: Phyllanthaceae	B: Amlaki H: Amla E:Indian gooseberry	Pulp paste of succulent fruit as immuno-stimulant and during recovery from chronic diseases [4].	Immunostimulant [121]; Anti-microbial [82]; fruit juice in septic fever and leucorrhoea [27].
Eutrema japonicum (Miq.) Koidz. Family: Brassicaceae	B: Oyasabi H: Vasaabee E: Wasabi	Paste of rhizome to be used orally to prevent heart disease, cancer, and osteoporosis [122].	It seems to have antibacterial, anti-cancer and anti-inflammatory effects. It also seems to slow blood clotting and stimulate bone growth [122].
Hibiscus sabdariffa L. Family: Malvaceae	B: Mesta H: Meshta E: Roselle	Paste or juice of leaves for treatment of chronic anemia, prevention of osteoporosis among females. Good tonic for children and adults. It contains very good amount of Vit. C, Vit. A, Calcium, Iron, Magnesium etc. [165].	It is used in folk medicine as a diuretic, mild laxative, and treatment for cardiac and nerve diseases [165].
Holarrhena pubescens Wall. ex G.Don *Holarrhena antidysenterica* (L) Family: Apocynaceae	B: Kurchi H: Karva indrajau E:Indrajao	Watery extract of succulent stem bark for treatment of dysentery and bloody enteritis and Irritable Bowel syndrome [123].	It has ant dysenteric, antidiarrheal, anti-amoebic properties. In Ayurveda, it is used in treatment of dysentery, diarrhea, irritable bowel syndrome, bleeding piles, liver disorder [123]. Bark in amoebic dysentery, tonic, febrifuge, Tuberculosis [89].
Hygrophila auriculata (Schumach.) Heine. *Hygrophila spinosa* T.And. Family: Acanthaceae	B. Kulekhara H. Gokulakanta E. Hygrophila	Leave juice to be used in female anemia [124], excessive menstrual bleeding, dysmenorrhea, Leucorrhoea [125].	Plant is used in jaundice, rheumatism, renal stone, gonorrhoea, hepatic disorder, varicose vein etc. [124]. Also, in the treatment of anasarca, diseases of the urinogenital tract, dropsy from chronic Bright's disease, hyperdipsia,

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
			vesical calculi, flatulence, diarrhea, dysentery, leukorrhea, asthma, blood diseases, gastric diseases, inflammation, cancer, rheumatism, painful micturition, menorrhagia [126].
Lagenaria vulgaris Ser. Family: Cucurbitaceae	B: Lau H: Lauki E: Bottle gourd	Juice of premature whole fruit for external use for protection from skin diseases and internal use in chronic digestive problems [27].	Fruit juice externally in pyorrhea and different skin diseases, internally in chronic acidity and pyrexia with vomiting tendency [27].
Linum usitatissimum L. Family: Linaceae	B: Atasi H: Alsi E: Flaxseed/ Linseed	Seeds paste for protection of heart and as immunostimulant [4].	Infectious and non-infectious diarrhea [127], can reduce bad cholesterol [128].
Litsea glutinosa (Lour) C.B. Robins. Family: Lauraceae	B: Piplas/ Pipulti H: Maidalakdi E: Indian laurel	Leaf mucilage for oral intake for cooling of body system during summer, reduction of summer itches and as immunostimulant [4].	Leaves are mucilaginous and used as/ in antispasmodic, emollient, poultice, diarrhea and dysentery, wounds, bruises [129], curing of prickly heat, summer itches and acne [84].
Marsilea quadrifolia L. Family: Marsileaceae	B: Susni H: Sushni E: Water shamrock	Leaf juice for oral use in insomnia, dementia and high blood pressure [27].	Leaf juice also effective in asthma, high blood pressure, epilepsy etc. [27].
Mentha longifolia (L.) Huds. *Mentha spicata* L. Family: Lamiaceae	B: Pudina H: Pudina E: Mint	Leaf paste or juice for treatment of Irritable bowel syndrome [130] and other chronic digestive problems [4].	Used for treating of colds and flu, respiratory tract problems, gastralgia, hemorrhoids, and stomachache [131]. Leaf antiseptic, stimulant, fever [88].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Metroxylon sagu Rottb. Family: Arecaceae	B: Sagu H: Sago E: True sago palm	Dry sago to use as water added or slightly boiled sago as breakfast/ dinner for relieving from habitual constipation and control of blood sugar [132].	Hydrolysis of sago starch granules only up to 44.6% after 72 hours is possible. The sago starch is resistant to both microbial and enzyme digestion [132].
Mikania scandens B.L.Rob. Family: Asteraceae	B: Banchhalata H.Taralata E:Climbing hempweed	Leaf juice for external use as hemostatic, antiseptic and pain-relieving lotion for minor wounds of human and animals [84].	The plant is thought to be efficacious in the treatment of gastric problems including stomach ulcer [133]. The leaves applied to itches and in the form of poultice to wound [88].
Momordica charantia L. Family: Cucurbitaceae	B: Uchhey H: Karela E: Bitter gourd	Succulent fruit extract orally for prevention of diabetes [4]	Leaf juice in pin worm, joint pain; fruit juice in anorexia indigestion and allergy; root on old wounds [27]; leaf in Leprosy [85].
Moringa oleifera Lam. *Guilandina moringa* L. *Hyperanthera moringa* (L.) Vahl. Family: Moringaceae	B: Sojney H: Shajna E: Drumstick tree	Paste of old leaf in high blood pressure, paste of flower immunostimulant, paste of root as antimicrobial preservative [27].	Seed and leaf in Leprosy, cuts, wounds, snake and dog bite wounds [134].
Myristica fragrans Houtt. Family: Myristicaceae	B: Jaiphal, Jaitri H: Jaiphal Javitri E: Nutameg	Paste of both may be used to treat cancer and stomach ulcer at low doses after proper study [135].	Nutmeg and mace are used for diarrhea, nausea, stomach spasms and pain, and intestinal gas. They are also used for treating cancer, kidney disease, and trouble sleeping (insomnia); increasing menstrual flow [135].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Nigella sativa L. *Nigella cretica* Mill. Family: Ranunculaceae	B. Kalogira H. Kalongi E. Black cumin	Seed paste to be used as preventive and curative agent for heart patients and hypertensive patients [136, 137].	Seed as stimulant, diuretic, galactagogue; in skin affections [88]; in cancer, cardio vascular complications, diabetes, asthma, kidney diseases [136]; Active in asthma, bronchitis, high blood pressure, inflammation, migraine, rheumatoid arthritis, immune-boosting and antioxidant benefits [137].
Nyctanthes arbor-tristis L. *Bruschia macrocarpa* Bertol. Family: Oleaceae	B. Siuli H. Har Singer E.Night-flowering jasmine	Leaf juice as antipyretic and expectorant [88].	Having significant hepatoprotective, anti-leishmaniasis, antiviral, antifungal, antipyretic, antihistaminic, antimalarial, antibacterial, anti-inflammatory, antioxidant activities [138].
Ocimum sanctum L. Family: Lamiaceae	B: Tulsi H: Tulasi E: Holy Basil	Leaf extract with honey as expectorant and as immunostimulant [4].	Leaf stimulant, in bronchitis, skin infections; root in Malaria; seed in urinary tract disorders [88]. Additional report: Leaf juice act as digestive when juice is taken after lunch and also can act as healing agent on non-healing ulcers.
Origanum vulgare L. Family: Lamiaceae	B: Oregano tel H. Sathra E.Wild marjoram	Leaf paste or the oil to be used as an alternative of commonly used antibiotics in common problems of different organs like treating respiratory tract disorders, gastrointestinal disorders, urinary tract disorders [139].	Uses of the oil include treating respiratory tract disorders, menstrual cramps, and urinary tract disorders, can act against cancers, as antioxidant and in diabetes. When applied topically, helps to treat a number of skin conditions, such as acne and dandruff [139].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Pimenta dioica (L.) Merr. *Caryophyllus pimenta* (L.) Mill. *Eugenia micrantha* Bertol. Family: Myrtaceae	B: Kabab Chini H: Kabab Chini E: Allspice	The unripe berries at succulent or dry condition may be encapsulated to use in chronic indigestion and flatulence [140].	Allspice is used for indigestion (dyspepsia), intestinal gas, abdominal pain, heavy menstrualperiods, vomiting, diarrhea, fever, colds, high blood pressure, diabetes, and obesity. It is also used for emptying the bowels [141].
Piper betel L. Family: Piperaceae	B: Pan H: Tambul E: Betel	Juice of plant as mouth freshener, anti-flatulent and Immuno-stimulant [4] and as oral disinfectant, oral anti-ulcer agent [142].	Role in oral hygiene, as anti-diabetic, cardiovascular protector, anti-inflammatory, immune-modulatory, anti-ulcer, hepato-protective, anti-infective, anti-cancer effects [142].
Rheum emodi Wall. ex Meisn. *Rheum australe* D.Don Family: Polygonaceae	B. Rheuchini. H.Rewand Chini/ Amlavetasa E.Himalayan rhubarb, Indian rhubarb	Paste or extract of roots and rhizomes for use as immune-stimulant during disease condition and after recovery [143].	It has been traditionally used as diuretic, liver stimulant, purgative/ cathartic, stomachic, anti-cholesterolaemic, anti-tumor, antiseptic and tonic [144]; as laxative, tonic, diuretic and to treat fever, cough, indigestion, menstrual disorder. It possesses anticancer, antioxidant, anti-inflammatory, antimicrobial, antifungal, anti-diabetic, antiulcer, hepato-protective, immune-enhancing and nephroprotective activities [143].
Rosmarinus offinicalis L. Family: Lamiaceae	B: Rosemary H: Rosemary E: Rosemary	Leaf juice for boostering immunity power and improve memory power [145].	It is traditionally used to help alleviate muscle pain, improve memory, boost the immune and circulatory system, and promote hair growth [145].
Salvia officinalis L. Family: Lamiaceae	B: Bhui tulashi H: Sefakuss E: Common sage	Leaf juice for immunomodulation, increase efficacy of different body systems	It is used for digestive problems, including loss of appetite, flatulence, gastritis, diarrhea, bloating; for depression, diabetes, high cholesterol, cerebral ischemia; to improve memory

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
		and increase in memory power [146].	power, in Alzheimer's disease and to prevent lung cancer; in painful menstrual periods, to correct excessive milk flow during nursing, and to reduce hot flashes during menopause among women. For men, to reduce hot flashes for androgen deprivation therapy during treatment of prostate cancer. It is applied directly for cold sores, gingivitis, sore mouth, throat and tongue; in swollen, painful nasal passages, swollen tonsils. It is also applied to prevent sunburn. Some people inhale sage in asthma [146].
Saraca asoca (Roxb.) Willd. *Saraca indica* sensu Bedd., non L. Family: Fabaceae	B.Ashok H.Ashoka E. Saraca	The pressed watery extract of stem bark for oral use in dysmenorrhea and other gynecological problems [147].	Useful in congested uterus and pain, painful periods, fixed pain, clots and amenorrhea, endometritis [147].
Smilax ornate Lem. Family: Smilacaceae	B: — H: — E: Sarsaparilla	The root paste or juice for strengthening of liver, kidney, disease prevention power of skin and overall body immunity [148].	Used for treating psoriasis and other skin diseases, rheumatoid arthritis (RA), and kidney diseases; for increasing urination to reduce fluid retention and for increasing sweating. It is also used along with conventional drugs for treating leprosy and for syphilis [148].
Syngium Cumini (L) Skells. *Syzygium jambolanum* (Lam.) DC. Family: Myrtaceae	B: Jam H: Jamun E: Black plum	Fruit pulp for use as protector to heart problems and diabetes [4].	Bark in sore throat, bronchitis, asthma, dysentery, ulcer [89]; leaf juice in amoebiasis, as haemostatic; leaf extract and stem cover dust in old ulcers; seed in diabetes [27].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Swertia chirayita (Roxb.) Buch.-Ham. ex C.B. Clarke. Family: Gentianaceae	B: Chirata H: Chirayata E: Chirayata	Leaf paste as protective and curative of liver ailments, chronic diseases, indigestion [4].	It is a bitter tonic, carminative, laxative, anti-pyretic, febrifuge, anti-periodic, anti-inflammatory, stomachic, and anti-helminthic. It is used in treating piles, skin diseases, ulcers, and diabetes [149]; also used in asthma, liver diseases, internal hemorrhage of stomach [88].
Taraxacum officinale (L.) Weber ex F.H. Wigg. *Crepis taraxacum* (L.) Stokes Family: Asteraceae	B: Pitachumki H: Dudhi E: Dandelion	The plant juice for use as immuno-stimulant for treatment and prevention of various diseases like diabetes [150], spleen and liver problems, cancer etc. [151].	It is used for the treatment of dyspepsia, heartburn, spleen and liver complaints, hepatitis and anorexia etc. It has diuretic, choleretic, anti-inflammatory, anti-oxidative, anti-carcinogenic, analgesic, anti-hyperglycemic, anti-coagulatory and prebiotic effects [151].
Terminalia arjuna (Roxb.) Wight & Arn. Family: Combretaceae	B: Arjun H: Arjun E: White Marudah	The pressed watery extract of stem bark for oral use in heart patients [4].	Bark styptic, febrifuge; leave in ear ache [88]; bark wound healing [152].
Terminalia chebula Retz. Family: Combretaceae	B: Haritaki H: Haritaki E: Black myrobalan	Powder of dried ripe fruit as overall immunostimulant, in kidney and liver problems [153].	Fruit tonic, bark diuretic [88]; fruit in chronic ulcers, wounds, scalds [89]. It has antitussive, cardiotonic, homeostatic, diuretic and laxative effects [153].
Thymus vulgaris L. Family: Lamiaceae	B: Jangli jawan H: Bana jwain E: Common thyme	Leaf juice in cough and bronchitis [154].	It is taken in bronchitis, whooping cough, sore throat, colic, arthritis, upset stomach, gastritis, diarrhea, bedwetting, dyspraxia, flatulence, parasitic worm infections, as diuretic, urinary antiseptic and skin disorders [154].
Tinospora cordifolia (Thunb.) Miers. Family: Menispermaceae	B: Gulancha H: Giloy E: Indian Tinospora	Paste of pulp of succulent stem as immunostimulant, in chronic diseases [121, 155].	Tonic, febrifuge, analgesic, urinary diseases, jaundice, rheumatism, Leprosy [88].

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Plant (scientific name and synonyms)	Name (B= Bengali H= Hindi E= English)	Proposed preparation for use with related reference	Other reported effects on health
Trigonella foenum-graecum L. Family: Fabaceae	B: Methi H: Methi E: Fenugreek	Paste of seeds for use in pre-diabetes [4].	Seed tonic, used in intestinal inflammation, boils and ulcers [88].
Vaccinium corymbosum L. Family: Ericaceae	B: — H: — E:Northern highbush blueberry	Fruit pulps to be used for prevention of cancers and heart diseases [156].	It is also used for improvement of memory and thinking skills and treatment of urinary tract infections and depression [156].
Vernonia amygdalina Delile. Family: Asteraceae	B: — H: — E: Bitter leaf	The juice of young shoots for use as anti-parasitic, anti-dysentery, in gastro intestinal infections etc. [157].	A concoction of this plant is prescribed treatment for malarial fever, schistosomiasis, amoebic dysentery, several other intestinal parasites, and stomachaches by many African ethnic groups [157]. A self medicine of Chimpanzee.
Withania somnifera (L.) Dunal. Family: Solanaceae	B: Aswagandha H: Aswagandha E: Indian ginseng	Root paste for restoration of sexual power [4].	Root in cough, rheumatism, female disorders, ulcers; leaf febrifuge; in lesions, sore eyes [88]; immunostimulant [121]; antiseptic, in wound healing [89].
Zingiber officinale Roscoe. Family: Zingiberaceae	B: Ada H: Adrak E: Ginger	Paste/ juice of rhizome in pharyngitis and common cold [88].	Rhizome antioxidant, stimulant [88]; Pieces of succulent rhizome taken orally with salt in pharyngitis, common cold; considered immunostimulant [4].

Example of combinational use of plant parts for a specific health purpose

1.In Gynecological problems Plants a. *Moringa oleifera* Lam. b. *Saraca asoca* (Roxb.) Willd. c. *Terminalia arjuna* (Roxb.) Wight & Arn	Use The pressed watery extract of stem bark of these three trees are to be mixed/ kept separately to mix before use as oral medicine in dysmenorrhea and leucorrhoea.
2.Prevention and treatment of anemia and osteoporosis among females. Plants a. *Hibiscus sabdariffa* L b. *Hygrophila auriculata* (Schumach.) Heine.	Use Leaf juice of the plants may be fed separately for the purposes.

Chapter XIII

A model treatment schedule for some common diseases

In the proposed healthcare system, more importance should be given on prevention, rather than cure of the diseases. So, stimulation of body immunity towards desirable aspect should be a strong pillar of that healthcare system. Detail research should be performed on effective use of various immuno-stimulating medicines and other healthcare products through selective intake and use of them. As a beginning of such study, some initial points may be considered. For that reason, a model for such study is attached in Table 12.

Table 12. A model study pattern for initiation of research to use oral bio-medicines in the proposed healthcare system[#].

Purpose	Initial indication	Treatment days[@]							Other indication/s*
Basic immuno-stimulation of persons above 13 years of age	—	Day 1-2	Day 3-5	Day 6-7	Day 8	Day 9	Day 10-12	Day 13-15	1. Intake of available bio-fruit pulps/ fruit juices. 2. Intake of 3-4 ml of lemon juice in luke-warm water at morning instead of tea is beneficial.
		Bail	Carrot	Turmeric	Kalmegh	Goose berry	Garlic	Carrot	
For skin problems	Basic immuno-stimulation 1-15 days	Day 16	Day 17-18	Day 19-22	Day 23	Day 24-25	Day 26-28	Day 29-30	1 & 2 Same. 3. Neem paste +Turmeric paste + Mustard/ olive oil before bathe once or twice per week four weeks. 4.Other specific therapy for specific problem.
		Neem oral	Goose berry	Carrot	Kalmegh	Rest	Turmeric	Carrot	
For persons having te ndency to suffer from various diseases	Basic immuno-stimulation 1-15 days	Day 16 -17	Day 18	Day 19-20	Day 21-22	Day 23	Day 24-25	26-30	1 & 2 Same.
		Rest	Kalmegh	Rest	Garlic	Goose berry	Tinospora	Turmeric	
For persons having tendency to suffer allergic and respiratory problems	Basic immuno-stimulation 1-15 days	Day 16	Day 17	Day 18	Day 19-24	Day 25	Day 26-27	Day 29-30	1 & 2 Same.3. Basil with honey may be given afterwards. 4. Ginger, Malabar nut etc. may be taken if coughing is there.
		Goose berry	Neem oral	Rest	Basil with honeyDay	Kalmegh	Goose berry	Tinospora	

Purpose	Initial indication	Treatment days[@]							Other indication/s*
For pre-diabetic persons	Basic immuno-stimulation 1-15 days	Day 16 -17	Day 18-19	Day 20—22	23—24	Day 25—26	Day 27—29	Day 30	1 &2 Same. 3.Lifestyle modification[$] 4.Intake of Flaxseed, Almond, Bitter gourd, Drumstick flower, Black plum, Fenugreek etc. are advocated.
		Neem oral	Goose berry	Bitter gourd	Black plum	Kalmegh	Goose berry	Tinospora	
For diabetic persons	Basic immuno-stimulation 1-15 days	The treatment schedule of the pre-diabetics may be added with validated medicines like Cayenne Jasmine, Fiery Costus etc.							
For anemic persons	Basic immuno-stimulation 1-15 days	Day 16	Day 17-22	Day 23-24	Day 25	Day 26 -27	Day 28 -29	Day 30	1 &2 Same. 3. Worm infestation, excessive menstrual bleeding etc. should be ruled out. 4. Leafy vegetables are recommended in diet
		Chira yata	Hygrophila + Maize dust/raw *Hibiscus sabdariffa* leaf extract	Carrot	Tinospora	Goose berry	Hygrophila + Maize dust	Turmeric	

[#]As it is a model, only the commonly used plant medicines are shown. However, the practical schedule may be with other validated bio-medicines.

[@] As per the person and requirement, the schedule may be repeated or other specific therapy may be started.

[*]It is always advisable to stop intake of any chemical added fast foods, fried foods with hydrogenated vegetable oils, or fried in repeated boiled oils, the chemical added so called fruit drinks, all chemical-made drinks sold in different names.

[$] Physical exercise, stay away from all processed foods and sugars, fried items. Sleeping after 3 hours of taking meal within 10 P.M. and rising at morning, walking etc.

Chapter XIV

Lifestyle factors: the strongest weapon working against continuation of healthy life

Man is among the most recent creatures of the world. During the stages of development and adaptation of a part of the ape species to become human, we never neglected adjustment with the nature.

As for example - the animals and birds of the world are adjusted to work either at dark or under the light. The nocturnal species are adapted to work and move at dark, i.e., at night and others are adapted with the sunlight during their active periods. It is an adjustment of at least of some millions of years for man. But in recent years, to follow the uni-directed concept and path of development, we are neglecting that already adapted principle. Working at night and sleeping at day time or any irregular mixture of this time schedule is against the adapted principles, though it is a demand of the present time to many people for their earning. But such practices are against or reverse to the normal lifestyle factors developed through adaptation of a long time, so the reactions of such practices are seen on our health.

Likewise, leaving the habit of taking fruits, vegetables, pulses, animal proteins etc. as some food at natural or near to natural stage and taking food or drinks with some abnormal materials in them, our health cannot find the way to work properly. Health effects of boiling of any food item in water expected to be tolerated better to our body than the microwave treated foods or the deeply fried foods. The synthetic chemicals used in food and drinks (as chemicals added and used during preparation of all processed foods, chemical added drinks etc.), the adulterants, the genetically modified foods, the abnormally created food items (as hydrogenated vegetable oils) etc. may be treated as 'not normal' by our body system. In such cases, these are definitely affecting our health, whether it can be proved by our present stage of analytical systems or not.

In relation to the proposed novel healthcare system, the concept of Molecular Pathological Epidemiology (MPE) was discussed in the Volume 1 of this book. For the best action of the bio- medicines and other bio-products discussed under this system, following of a model lifestyle is essential. However, if efforts are continued, the highest

possible portion of such lifestyle can be followed by the individuals. Many good articles and books are written on different aspects of effect of lifestyle factors on health and the ways to reduce the unwanted effects [158, 159]. Some organizations also published articles or leaflets on that topic to increase consciousness of the common people [160, 161, 162]. It is not the place for discussion on this important topic, but the aspects like following of designed lifestyle, self arrangement for psychological recreations etc. may have some strong added effects in this area.

However, following points related mainly with intake of foods and their effective use may be considered for that purpose.

*Lifestyle factors like restriction in selection of food/food items, time and amount of intake of food, physical exercise (Heavy muscular /free hand/ special like swimming etc.), sleeping time and period, meditation, specific yoga practice etc. should be followed as per instructions of the experts.

* For effective use of herbs as medicine, entry of toxic chemicals inside the body should be targeted as zero.

Selection of proper edible items for healthy life and preparation of healthy foods

a) **Fruits**: All edible fruits like Anaras, kiwi, khejur, papaya, guava, apple, orange etc. can be taken, if problems like allergy to any of them are not reported. 'One fruit per person per day' may be a good option. The proposed fruit products are designed with an intension to supply these fruits to the people of all ages, all choices and throughout the year (Table 9). Many people, particularly of younger generations, never like to eat fruits directly. The children may not agree to eat a full fruit. The proposed products many cover requirements of all such people. But all processed and/or bottled fruit juices added with any chemical of any name should be avoided.

b) **Oils:** Oils with Mono unsaturated fatty acids are safe. Poly unsaturated fats with calculation of omega 3 and omega 6 fatty acids may also be selected for use. Hydrogenated vegetable oils, saturated oils and fats, all trans-fats should be avoided. Food prepared in oils fried at some very high temperature or in repeatedly boiled oil also should be avoided [38].

c) **Food and water:** Homemade foods prepared in the heat (not in microwave) are the best option. All processed foods at any form and any name may be avoided. These are prepared in and added with many chemicals which may have some detrimental effect on our health [8]. The practice of use of plastic packets or bottles to keep water is not good for our health as these may contains micro and nano plastics which may be very toxic to our health. Hot beverages like tea and any hot food should never be taken in any plastic cup or pot, as they may receive leached color and plastic additives from the container which may

cause many serious health problems [163]. The simply filtered water kept in glass made bottle may be the best option, as the water filtered by reverse osmosis process may not be healthy due to loss of natural minerals present in the water [164].

d) **Sweetener:** Use of molasses, honey etc. natural sweeteners should be preferred as these are far better than the sweet tasted chemicals sold under the heading of artificial sweetener or the industrially manufactured sweeteners.

e) **Yogurt**: Intake of yogurt after lunch may be a good option.

This is an incomplete discussion. Like all the sections of the book, further addition and/or alterations are to be performed as per the study reports by the concerned experts in this section also.

Chapter XV

Bibliography

[1] Naddaf J. Natural food preservation. www.effinghamlibrary.org.

[2] Singh RP, McLellan MR. Fruit processing. Encyclopaedia Britannica, Inc. 2016; https://www.britannica.com/topic/fruit-processing. Accessed on 10.09.2019.

[3] Fruit juice toolkit, FAO. http://www.fao.org/3/a-au112e.pdf Under: http://www.fao.org/in- action/inpho/resources/toolkit/en ?page=3&ipp=5&tx_dynalist_pi1%5Bpar%5D=YToxOntzOjE6IkwiO3M6MToiMCI7fQ%3D%3D

[4] Pattanayak S. Healthcare system using succulent parts of plants. Volume 1: For infectious diseases, 2019; 01-144.

[5] Sasidharan S, Chen Y, Saravanan D, Sundram KM, Yoga Latha L. Extraction, isolation and characterization of bioactive compounds from plants' extracts. Afr J Tradit Complement Altern Med 2011; 8(1): 01-10.

[6] Pratheepa V, Sukumaran N. Specific and nonspecific immuno-stimulation study of *Euphorbia hirta* on *Pseudomonas fluorescens*-infected *Cyprinus carpio*. Pharmaceut Biol 2011; 49(5): 484-491.

[7] OECD guidelines for the testing of chemicals. Available from:http://www.oecdilibrary.org/environment/oecd-guidelines-for-the-testing-ofchemicals_chem_guide_pkg-en.

[8] Pattanayak S. Processed foods – are they safe? Explor Anim Med Res 2017; 7(2): 125-131.

[9] Scuola italiana di Madrid. Chemistry in our life. Downloaded on 09.09.2019.

[10] Abdulmumeen HA, Risikat AN, Sururah AR. Food: Its preservatives, additives and applications. Intern J Chemic Biochemic Sci 2012; 1: 36-47.

[11] Sharma S. Food Preservatives and their harmful effects. Intern J Scientif Res Publ 2015; 5(4) 1-2.

[12] Saulo AA. Sugars and sweetners in foods, food safety and technology. Published by college of tropical agriculture and human resources, University of Hawai' at Manoa, 2005; FST-16: 1-7, Cited in: Abdulmumeen HA, Risikat AN, Sururah AR. Food: Its preservatives, additives and applications. Intern J Chemic Biochemic Sci 2012; 1: 36-47.

[13] Rawat S. Food spoilage: Microorganisms and their prevention. Asian J Plant Sci Res 2015; 5(4): 47-56.

[14] Lopez. A. A complete course in canning. Books I, II, III. The canning trade inc., Baltimore MD 21218-4576. 1987. Cited in Abdulmumeen HA, Risikat AN, Sururah AR. Food: Its preservatives, additives and applications. Intern J Chemic Biochemic Sci 2012; 1: 36-47.

[15] Deeley CM, Gao M, Hunter R. The development of food in Asia Pacific radiation processing, 2006; pp. 11-15. Cited in Abdulmumeen HA, Risikat AN, Sururah AR. Food: Its preservatives, additives and applications. Intern J Chemic Biochemic Sci 2012; 1: 36-47.

[16] Wood OB, Bruhn CM. Position of the American dietetic association: food irradiation. J Am Diet Assoc. 2000; 100(2):246-253. Cited in Abdulmumeen HA, Risikat AN, Sururah AR. Food: Its preservatives, additives and applications. Intern J Chemic Biochemic Sci 2012; 1: 36-47.

[17] Deeley CM, Gao M, Hunter R, Ehlermann DAE. The development of food irradiation in the Asia Pacific, the Americas and Europe; tutorial presented to the international meeting on radiation processing, Kuala Lumpur. 2006; Cited in Abdulmumeen HA, Risikat AN, Sururah AR. Food: Its preservatives, additives and applications. Intern J Chemic Biochemic Sci 2012; 1: 36-47.

[18] Church JJ, Parson AL. Modified atmosphere packaging technology: a review, J Sci Food Agri, 1995; 67:143-152, Cited in: Abdulmumeen HA, Risikat AN, Sururah AR. Food: Its preservatives, additives and applications. Intern J Chemic Biochemic Sci 2012; 1: 36-47.

[19] Riddervold A. High pressure food preservation, food conservation. 2008; pp. 12-16, Cited in: Abdulmumeen HA, Risikat AN, Sururah AR. Food: Its preservatives, additives and applications. Intern J Chemic Biochemic Sci 2012; 1: 36-47.

[20] Hamid AA, Ahmed NR, Agboola RS. Food: Its preservatives, additives and applications. Intern J Clinical Biol Sci 2012: 36-47.

[21] Mirza SK, Asema UK, Sayyad SK. To study the harmful effects of food preservatives on human health. J Medicinal Chemist Drug Discovery 2017; 2(2): 610-616.

[22] Anand SP, Sati N. Artificial preservatives and their harmful effects: looking toward nature for safer alternatives. Int j Pharmaceut Sci Res 2013; 4(7): 2496-2501.

[23] Santos-Sánchez NF, Salas-Coronado R, Valadez-Blanco R, Hernández-Carlos B, Guadarrama-Mendoza PC. Natural antioxidant extracts as food preservatives. Acta Sci Pol Technol Aliment 2017; 16(4): 361-370.

[24] Fruit processing toolkit, Preservatives. Food and agricultural organisation of United Nations. http://www.fao.org/3/a-au117e.pdf, Under: http: www.fao.org/in - action/ inpho/resources/toolkit/en/?page=3&ipp=5&tx_dynalist_pi1% 5Bpar%5D= YToxOntzOjE6IkwiO3 M6MToiMCI7fQ%3D%3D

[25] Hayek SA, Gyawali R, Ibrahim SA. Antimicrobial natural products. In: Microbial pathogens and strategies for combating them: science, technology and education, Volume 2 (A. Méndez- Vilas Eds.). Spain. 2013; Formatex Research Center.

[26] Pattanayak S, Mandal TK, Bandyopadhyay SK. Validation and therapeutic use of succulent plant parts - opening of a new horizon of alternative medicine. Explor Anim Med Res 2016; 6(1): 8-14.

[27] Bhattacheryya S. Chiranjib Banousodhi (Bengali) Part I and Part 2. (1976 -1977) Ananda Publishers Pvt. Ltd. Kolkata – 700009, India.

[28] Bassolé IH, Juliani HR. Essential oils in combination and their antimicrobial properties. Molecules 2012; 17(4): 3989-4006.

[29] Silva JMA, Santos SMD, Pintado ME, PérezÁlvarez JA, Fernández-López J, Viuda-Martos M. Chemical composition and in vitro antimicrobial, antifungal and antioxidant properties of essential oils obtained from some herbs widely used in Portugal. Food Control 2013; 32: 371-378.

[30] Embuscado ME. Spices and herbs: natural sources of antioxidants – a mini review. J Functional Foods 2015; 18: 811-819.

[31] Prakash B, Kiran S. Essential oils: a traditionally realized natural resource for food preservation. Current Sci 2016; 110(10): 1890 -1892.

[32] Erginkaya Z, Konuray G. Natural preservatives: an alternative for chemical preservative used in foods. Intern J Nutrit Food Engine 2017; 11(4): 311-316.

[33] Dwivedi S, Prajapati P, Vyas N, Malviya S, Kharia A. A review on food preservation: methods, harmful effects and better alternatives. Asian J Pharmac Pharmacol 2017; 3(6): 193-199.

[34] Manikkam V. Natural alternatives to chemical food preservatives: plant based is the new trend. 2018; https://www.prescouter.com/2018/04/natural-alternatives-chemical-food-preservatives/ Downloaded on 07.09.19.

[35] Campêlo MCS, Medeiros JMS, Silva JBA. Natural products in food preservation. Intern Food Res J 2019; 26(1): 41-46.

[36] Ebrahimi M, Khosravi-Darani K. Essential oils as natural food preservatives: antimicrobial and antioxidant applications, in Doughari J (Editor), Antimicrobials from nature: effective control agents for drug resistant pathogens. 2013; Transworld research network 37/661 (2), Fort P.O. Trivandrum-695 023, Kerala, India.

[37] Schlosser I, Prange A. Antifungal activity of selected natural preservatives against the foodborne molds *Penicillium verrucosum* and *Aspergillus westerdijkiae.* FEMS Microbiology Letters 2018; 365(13): 1-13.

[38] Pattanayak S. Trans-fats of processed and fried foods – a choice for taste or serious health problems? Explor Anim Med Res 2019; 9(1): 05-14.

[39] Nedovic V, Kalusevic A, Manojlovic V, Levic S, Bugarsk B. An overview of encapsulation technologies for food applications. 11th. International congress on engineering and food (ICEF11). SciVerse Science Direct, Procedia Food Science 1. 2011; 1806-1815.

[40] Wandrey C, Bartkowiak A, Harding SE. Materials for encapsulation. From: N.J. Zuidam and V.A. Nedoviæ (eds.), Encapsulation technologies for active food ingredients and food processing, Chapter 3. 2010; Springer Science, LLC.

[41] Poncelet D, Picot A, Jian SEM. Encapsulation: an essential technology for functional food applications. Innovations in Food Technology (www.innovationsfood.com), 2011; CAPSULÆ, Rue de la Géraudière, BP 82225, F – 44322 Nantes, Cedex 3, France.

[42] Hsieh YF, Chen TL, Wang YT, Chang JH, Chang HM. Properties of liposomes prepared with various lipids. J Food Sci 2002; 67(8): 2808-2813.

[43] Thompson AK, Singh H. Preparation of liposomes from milk fat globule membrane phospholipids using a Microfluidizer. J Dairy Sci 2006; 89: 410-419.

[44] Rai VR, Bai JA. Nanotechnology applications in the food industry. 2018; CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742.

[45] Shori AB. (2017) Microencapsulation improved probiotics survival during gastric transit. Plant materials-based microencapsulation. HAYATI J Biosciences 2017; 24: 01-05.

[46] Etchepare MA, Raddatz GC, Flores EMM, Zepka LQ, Jacob-Lopes E, Barin JS, Grosso CRF, de Menezes CR. Effect of resistant starch and chitosan on survival of *Lactobacillus acidophilus* micro-encapsulated with sodium alginate. LWT - Food Sci Technol 2016; 65: 511-517.

[47] Holkem AT, Raddatz GC, Nunes GL, e Cichoski AJ, Jacob-Lopes E, Grosso CRF, de Menezes CR. Development and characterization of alginate microcapsules containing Bifidobacterium BB-12 produced by emulsification/internal gelation followed by freeze drying. LWT - Food Sci Technol 2016; 71: 302 -308.

[48] Gebara C, Chaves KS, Ribeiro MCE, Souza FN, Grosso CRF, Gigante ML. Viability of *Lactobacillus acidophilus* La5 in pectin–whey protein microparticles during exposure to simulated gastrointestinal conditions. Food Research Internat 2013; 51: 872–878.

[49] Coghetto CC, Brinques GB, Siqueira NM, Pletsch J, Soares RMD, Ayub MAZ. Electrospraying microencapsulation of *Lactobacillus plantarum* enhances cell viability under refrigeration storage and simulated gastric and intestinal fluids. J Functional Foods 2016; 24: 316–326.

[50] Yonekura L, Sun H, Soukoulis C, Fisk I. Microencapsulation of *Lactobacillus acidophilus* NCIMB 701748 in matrices containing soluble fibre by spray drying: Technological characterization, storage stability and survival after *in vitro* digestion. J Functional Foods 2014; 6: 205-214.

[51] Neary MP. Food spoilage indicator. (A patent) 1978; https://patents.google.com/patent/US4285697A/en.

[52] Rukchon C, Nopwinyuwong A, Trevanich S, Jinkarn T, Suppakul P. Development of a food spoilage indicator for monitoring freshness of skinless chicken breast. Talanta, 2014; 130: 547-554.

[53] WHO. What is VVM and how does it work? https://www.who.int immunization_standards/vaccine_quality What%20is%20VVM%20and%20how%20does%20it% 20work.pdf?ua=1.

[54] Kartoglu U. WHO, UNICEF urge use of vaccine vial monitors. 2007; https://www.healio.com/infectious-disease/vaccine-preventable-diseases/news/print/infectious-disease-news/%7B56d61fc7-6265-4cb3-9b6e-828699c1b804%7D/who-unicef-urge-use-of-vaccine-vial-monitors.

[55] Pattanayak S. Use of 'Vaccine Vial Monitor' in all animal and bird vaccines – a demand of the day. Explor Anim Med Res 2013; 3(1): 5-6.

[56] Sharma SK, Sharma Y, Sharma E, Kumar S. Vaccine vial monitors (VVMs): applications and challenges. The Pharma Innovation J 2017; 6(3): 01-06.

[57] PQS performance specification (WHO/PQS/E06/IN05.1) 2006; https://www.unicef.org/videoaudio/PDFs/Annex_B_-_WHO_VVM.pdf

[58] Zweig SE. Advances in vaccine stability monitoring technology. Vaccine. 2006; Available at www.sciencedirect.com.

[59] Kiwifruit, green, raw. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber: 9148.

[60] Rathore M. Nutrient content of important fruit trees from arid zone of Rajasthan. J Horticult Forestry 2009; 1(7): 103-108.

[61] Bhardwaj R, Nandal U. Nutritional and therapeutic potential of Bael (*Aegle marmelos* Corr.) fruit juice: a review. Nutrition Food Sci, 2015; Vol. 45(6): 895-919.

[62] U.S. Department of Agriculture (USDA). Pineapple, raw, all varieties. Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber: 9266.

[63] Jackfruit, raw. U.S. Department of Agriculture (USDA). 2019;

https://fdc.nal.usda.gov/fdc-app.html#/food-details/174687/nutrients. Downloaded on 10.09.19.

[64] Carambola, (starfruit), raw. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber: 9060.

[65] Sandhya S, Sudhakar K, David Banji, Rao KNV. Pharmacognostical standardization of *Borassus Flabellifer* root. Annals of Biol Res 2010; 1(4): 85-94.

[66] Papayas,raw. U.S. Department of Agriculture (USDA). National Nutrient Database for Standard Reference Legacy Release, 2018; https://ndb.nal.usda.gov/ndb/foods/show/2305?fgcd=&manu=&lfacet=&format=Full&count=&max=35&offset=&sort=&qlookup=09226=Full.

[67] Oranges, raw, all commercial varieties. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html# ?query=ndb Number:9200.

[68] Strawberries, raw. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9316.

[69] Apple raw, with skin. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9003.

[70] Mangos, raw. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9176.

[71] Sapodilla, raw. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9313.

[72] Souli A, Sebai H, Rtibi K, Chehimi L, Sakly M *et al*. Effects of dates pulp extract and palm sap (*Phoenix dactylifera* L.) on gastrointestinal transit activity in healthy rats. J Med Food. 2014; 17(7):782–786.

[73] Dates, deglet noor. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9087.

[74] Plums, raw. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9279. Downloaded on 11.08.2019

[75] Guavas, common, raw. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9139'

[76] Pomegranates, raw. U.S. Department of Agriculture (USDA). Food data central, 2019; https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9286.

[77] Blackberry. Wikipedia. U.S. Department of Agriculture (USDA). Food data central, 2019; https://en.wikipedia.org/wiki/Blackberry. Downloaded on 22.08.2019.

[78] Grapes, red or green (European type, such as Thompson seedless), U.S. Department of Agriculture (USDA). Food data central, 2019. https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:9132. Downloaded on 12.08.2019.

[79] Halla N, Fernandes IP, Heleno SA, Costa P, Boucherit-Otmani Z, Boucherit K, Rodrigues AE, Ferreira ICFR, Barreiro MF. Cosmetics preservation: a review on present strategies. Molecules 2018; 23(1571): 1-41.

[80] Pandikumar P, Chellappandian M, Mutheeswaran S, Ignacimuthu S. Consensus of local knowledge on medicinal plants among traditional healers in Mayiladumparai block of Theni District, Tamil Nadu, India. J Ethnopharmacology 2011; 134(2), 354-362.

[81] Rajakaruna N, Harris CS, Towers GHN. Antimicrobial activity of plants collected from Serpentine outcrops in Sri Lanka. Pharmaceutical Biology 2002; 40 (3): 235-244.

[82] Dabur R, Gupta A, Mandal TK, Singh DD, Bajpai V, Gurav AM, Lavekar GS. Antimicrobial activity of some Indian medicinal plants. Afr J Tradit Compl Altern Medic 2007; 4(3): 313-18.

[83] Imran I, Hussain L, Haq MZU, Janbaz KH, Gilani AH, Vincenzo De Feo. Gastrointestial and respiratory activities of *Acacia leucophloea*. J Ethnopharmacology 2011; 138(3): 676-682.

[84] Pattanayak S, Dutta MK, Debnath PK, Bandyopadhyay SK, Saha B, Maity D. A study on ethno-medicinal use of some commonly available plants for wound healing and related activities in three southern districts of West Bengal, India. Explor Anim Med Res 2012; 2(2): 97-110.

[85] Chopra RN, Nayar SL, Chopra RC. Glossary of Indian medicinal plants, Council of Scientific and Industrial Research, New Delhi, India,1956.

[86] PerumalSamy RP, Ignacimuthu S, Sen A. Screening of 34 Indian medicinal plants for antibacterial properties. J Ethnopharmacol 1998; 62:173-82.

[87] Tropical Plants Database, Ken Fern. tropical.theferns.info. tropical.theferns.info/viewtropical.php?id=Acalypha+indica. Downloaded on 2019-09-17.

[88] Ambasta SP. The useful plants of India. National Institute of Science Communication and Information Resources. CSIR, New Delhi. 1986.

[89] Jain SK. Medicinal plants. National Book Trust, New Delhi, India. 1996.

[90] Chakraborty AK, Gaikwad AV, Singh KB. Phytopharmacological review on *Acanthospermum Hispidum*. J Applied Pharmaceut Sci 2012; 2: 144-148.

[91] Jeevan Ram A, Bhakshu LM, Venkata Raju RR. *In vitro* antimicrobial activity of certain medicinal plants from Eastern Ghats, India, used for skin diseases, J Ethnopharmacol 2004; 90: 353-357.

[92] Gangwar AK, Ghosh AK. Medicinal uses and pharmacological activity of *Adhatoda vasica*. Intern J Herbal Med 2014; 2(1): 88-91.

[93] Claeson UP, Malmfors T, Wikman G, Bruhn JG. *Adhatoda vasica*: a critical review of ethnopharmacological and toxicological data. J Ethnopharmacology 2000; 72: 1-20.

[94] Doherty VF, Olaniran OO, Kanife UC. Antimicrobial activities of *Aframomum melegueta* (Alligator Pepper). Intern J Biol 2010; 2(2): 126 -131.

[95] Dybas CL, Raskin I. Out of Africa: a tale of Gorillas, heart disease and a swamp plant. Bio Science 2007; 57(5): 392-397.

[96] Arreola R, Quintero-Fabián S, López-Roa RI, Flores-Gutiérrez EO, Reyes-Grajeda JP, Carrera-Quintanar L, Ortuño-Sahagún D. Immunomodulation and anti-inflammatory effects of garlic compounds. J Immunology Res 2015; 401630: 01-13.

[97] Duke JA. *Ananas comosus* (L.) Merr. Handbook of energy crops (unpublished). 1983. https://hort.purdue.edu/newcrop/duke_energy/Ananas_comosus.html.

[98] Studies in Botany. Medicinal uses of *Ananas comosus*.http://studies-in botany.blogspot.com/2014/05/medicinal-uses-of-ananas-comosus.html. Downloaded on 10.09.2019.

[99] Pattanayak S, Mandal TK, Bandyopadhyay SK. Use of plants as digestive stimulator and tonic in three southern districts of West Bengal, India. Intern J Herbal Medic 2015; 3(5): 01-08.

[100] Joy PP, Thomas J, Mathew S, Skaria BP. Medicinal Plants. Kerala agricultural university, Kerala, India. 1998.

[101] Lin JH, Giovannucci E. Environmental exposure and tumor heterogeneity in colorectal cancer risk and outcomes. Curr Colorectal Cancer Rep 2014; 10: 94-04.

[102] Musyimi DM, Ogur JA, Muema PM. (2007) Effects of leaf and root extracts of Aspilia plant (*Aspilia mossambicensis*) (Oliv) Wild. on some selected micro-organisms. Intern J Biol Chemistry 2007; 1(4): 213-220.

[103] Wrangham RW, Nishida T. *Aspilia* spp. leaves: a puzzle in the feeding behavior of wild chimpanzees. Primates 1983; 24(2):276-282. https://link.springer.com/article/10.1007%2FBF02381090.

[104] Pattanayak S, Mandal TK, Bandyopadhyay SK. A study on use of plants to cure enteritis and dysentery in three southern districts of West Bengal, India. J Medic Plants Studies 2015; 3(5): 277-283.

[105] Dey S, Banerjee D, Chattopadhyay S, Karmakar KB. Antimicrobial activities of some medicinal plants in West Bengal. Int J Pharm Biosci 2010; 1(3): 1-10.

[106] Roodenrys S, Booth D, Bulzomi S, Phipps A, Micallef C, Smoker J. Chronic effects of Brahmi (*Bacopa monnieri*) on human memory. Neuropsychopharmacology 2002; 27(2): 279-281.

[107] Bacopa. Webmd.com https://www.webmd.com/vitamins/ai/ingredientmono-761/bacopa. Downloaded on 11.09.2019.

[108] Ahmed N, Fazal H, Ayaz M, Abbasi BH, Mohammad I, Fazil L. Dengu fever treatment with *Carica papaya* leaves extracts. Asian Pac J Trop Biomed 2011; 1(4): 330-333.

[109] Sarala N, Paknikar SS. Papaya extract to treat Dengue: a novel therapeutic option? Ann Med Health Sci Res 2014; 4(3): 320-324.

[110] Ranasinghe P, Ranasinghe P, Abeysekera WP, Premakumara GA, Perera YS, Gurugama P *et al. In vitro* erythrocyte membrane stabilization properties of *Carica papaya* L. leaf extracts. Pharmacognosy Res 2012; 4:196-202.

[111] Mishra JN, Verma NK. A brief study on *Catharanthus roseus*: a review. Intern J Res Pharmacy Pharmaceut Sci 2017; 2(2): 20-23.

[112] Khan A, Safdar M, Ali Khan MM, Khattak KN, Anderson RA. Cinnamon improves glucose and lipids of people with type 2 diabetes. Diabetes Care 2003; 26(12): 3215-3218.

[113] Cinnamomum zeylanicum. https://www.alwaysayurveda.com/cinnamomum-zeylanicum/ Downloaded on 11.08.2019.

[114] Ranasinghe P, Pigera S, Premakumara GAS, Galappaththy P, Constantine GR, Katulanda P. Medicinal properties of 'true' cinnamon (*Cinnamomum zeylanicum*): a systematic review. BMC Complement Altern Med 2013; 13: 275.

[115] Verheij EWM, Coronel RE (eds) (1992) Plant resources of South east Asia – 2. Edible fruits and nuts. PROSEA, Bogor.

[116] Arias BA, Ramon-Laca L. Pharmacological properties of citrus and their ancient and medieval uses in the Mediterranean region. J Ethnopharmacology 2005; 97(2): 89-95.

[117] Xu G, Liu D, Chen J, e X, Ma Y, Shi J. Juice components and antioxidant capacity of Citrus varieties cultivated in China. Food Chemistry 2008; 106(2): 545-551.

[118] Mathew F, Varghese B. A review on medicinal exploration of *Costus igneus*: the insulin plant. Int J Pharm Sci Rev Res 2019; 54(2): 51-57.

[119] Pattanayak S, Mandal TK, Bandyopadhyay SK. Plants used to cure problems of flatulence and constipation in three southern districts of West Bengal, India. Explor Anim Med Res 2015; 5(2): 142-151.

[120] Mona SM, Hassan SK, Wadah JAO, Muddathir AK. A review on phytochemical profile and biological activities of three anti-inflammatory plants used in Sudanese folkloric medicine. Am J Pharm Tech Res 2014; 4(4): 01-14.

[121] Roychowdhury R. The healing powers of herbs. Mumbai, Pantaloons Retail India Ltd; 2008.

[122] Wasabi, Webmd.com https://www.webmd.com/vitamins/ai/ingredientmono-1525/wasabi

[123] Singh J. *Holarrhena antidysenterica* (*pubescens*) Kurchi (Kutaj). 2016;https://www.ayurtimes.com/holarrhena-antidysenterica-pubescens-kurchi-kutaj/. Downloaded on 08.09.2019.

[124] Gomes A, Das M, Dasgupta SC. Haematinic effect of *Hygrophila spinosa* T Anderson on experimental rodents. Indian J Traditional Knowle 2001; 39: 381-382.

[125] Pattanayak S, Mandal TK, Bandyopadhyay SK. Ethno-gynaecological study of the medicinal plants traditionally used in southern districts of West Bengal, India. Indian J Traditional Knowle 2016; 15(3): 482-486.

[126] Kshirsagar AD, Ingale KG, Vyawahare NS, Thorve VS. *Hygrophila spinosa*: a comprehensive review. Pharmacogn Rev. 2010; 4(8): 167-171.

[127] Palla AH, Khan NA, Bashir S, Ur-Rehman N, Iqbal J, Gilani AH. Pharmacological basis for the medicinal use of *Linum usitatissimum* (Flaxseed) in infectious and non-infectious diarrhea. J Ethnopharmacol 2015; 160: 61-68.

[128] Pan An, Yu Danxia, Demark-Wahnefried Wendy, Franco Oscar H, Lin Xu. Metaanalysis of the effects of flaxseed interventions on blood lipids. The Americ J Clinical Nutriti 2009; 90(2): 288-297.

[129] Bhowmick R, Sarwar MS, Dewan SMR, Das A, Das B, Uddin MMU *et al. In vivo* analgesic, antipyretic, and anti-inflammatory potential in Swiss albino mice and in vitro thrombolytic activity of hydroalcoholic extract from *Litsea glutinosa* leaves. Biol Res 2014; 47(56): 01-08.

[130] Peppermint oil. National center for complementary and alternative medicine, US National institutes of health. 2016; NCCIH Publication No.: D365.https://nccih.nih.gov/health/peppermintoil. Downloaded on 10.09.2019.

[131] Kee LA, Shori AB, Baba AS. Bioactivity and health effects of *Mentha spicata*. Integr Food Nutr Metab 2017; 5(1): 01-02.

[132] Karim AA, Tie APL, Manan DMA, Zaidul ISM. Starch from the Sago (*Metroxylon sagu*) palm tree-properties, prospects, and challenges as a new industrial source for food and other uses. Comprehends Rev Food Sci Food Safety 2008; 7(3): 215-222.

[133] Dey P, Chandra S, Chatterjee P, Bhattacharya S. Neuropharmacological properties of *Mikania scandens* (L.) Willd. (Asteraceae). J Adv Pharm Technol Res. 2011; 2(4): 255-259.

[134] Begum D, Nath SC. Ethnobotanical review of medicinal plants used for skin diseases and related problems in Northeastern India, J Herbs Spices Medici Plants 2000; 7: 55-93.

[135] Nutameg and Mace, Webmd.com.https://www.webmd.com/vitamins/ai/ingredientmono-788/nutmeg-and-mace Downloaded on 12.08.2019.

[136] Khan MA, Chen H, Tania M, Zhang D. Anticancer activities of *Nigella sativa* (Black cumin). African J Trad Complementary Alt Med 2011; 8(55): 225-232.

[137] Wong C. The health benefits of *Nigella Sativa*. 2019; https://www.verywellhealth.com/nigella-sativa-89064? Downloaded on 16.09.2019.

[138] Jadhav S, Patil MK. A review on: *Nyctanthes arbortristis* Linn. rejuvenating herb. Intern J Res Pharmacy Pharmaceut Sci 2016; 1(1): 54-62.

[139] Nordqvist J, Butler N. What are the health benefits of oregano? 2017; https://www.medicalnewstoday.com/articles/266259.php.

[140] Zhanga L, Lokeshwara BL. Medicinal properties of the Jamaican pepper plant *Pimenta dioica* and Allspice. Curr Drug Targets. 2012; 13(14): 1900-1906.

[141] Allspice, Webmd.com https://www.webmd.com/vitamins/ai/ingredientmono-81/allspice.

[142] Kumar N, Misra P, Dube A, Bhattacharya S, Dikshit M, Ranade S. *Piper betle* Linn.: a maligned pan-Asiatic plant with an array of pharmacological activities and prospects for drug discovery. Curr Sci 2010; 99: 922-932.

[143] Malik MA, Bhat SA, Fatima B, Ahmad SB, Sidiqui S, Shrivastava P. *Rheum emodi* as valuable medicinal plant. Intern J General Medic Pharmacy 2016; 5(4): 35-44.

[144] Zargar BA, Masoodi MH, Ahmed B, Ganie SA. Phytoconstituents and therapeutic uses of *Rheum emodi* wall. ex Meissn 2011; Food Chemistry 128: 585-589.

[145] Nordqvist J. Everything you need to know about rosemary. 2017; https://www.medicalnewstoday.com/articles/266370.php. Downloaded on 17.09.2019.

[146] Sage. Webmd.com. https://www.webmd.com/vitamins/ai/ingredientmono-504/sage

[147] Pradhan P, Joseph L, Gupta V, Chulet R, Arya H, Verma R, Bajpai A. *Saraca asoca*: a review. J Chem Pharmaceut res 2009; 1(1): 62-71.

[148] Sarsaparilla, Webmd.com. https://www.webmd.com/vitamins/ai/ingredientmono-379/sarsaparilla. Downloaded on 01.09.2019.

[149] Swertia chirata, Vikaspedia. http://vikaspedia.in/agriculture/crop-production/package-of-practices/medicinal-and-aromatic-plants/swertia-chirata. Downloaded on 11.09.2019.

[150] Wirngo FE, Lambert MN, Jeppesen PB. The physiological effects of Dandelion (*Taraxacum officinale*) in type 2 diabetes. Rev Diabet Stud. 2016; 13(2-3): 113–131.

[151] Schütz K, Carle R, Schieber A. Taraxacum - a review on its phytochemical and pharmacological profile. J Ethnopharmacology 2006; 107(3): 313-323.

[152] Jaiswal S, Singh SV, Singh B, Singh HN. Plants used for tissue healing in animals. Nat Prod Rad 2004; 3(4): 284-290.

[153] Tewari D, Mocan A, Parvanov ED, Sah AN, Nabavi SM, Huminiecki L, Ma ZF, Lee YY, Horbañczuk JO, Atanasov AG. Ethnopharmacological approaches for therapy of jaundice: part II. Highly used plant species from Acanthaceae, Euphorbiaceae, Asteraceae, Combretaceae and Fabaceae Families. Front Pharmacol 2017; 8: 519.

[154] Thyme, Webmd.com. https://www.webmd.com/vitamins/ai/ingredientmono-823/thyme.

[155] Biswas TK, Mitra A, Hazra A, Paul S, Debnath PK. Medicinal plants used in Ayurveda. National Medicinal Plants Board, Govt. of India. 2009.

[156] Blueberry, Webmd.com.https://www.webmd.com/vitamins/ai/ingredientmono-1013/blueberry Downloaded on 11.08.2019.

[157] Huffman MA. Self-medicative behaviour in the African Great Apes: an evolutionary perspective into the origins of human traditional medicine. BioScience 2001; 51(8): 651-661.

[158] Farhud DD. Impact of lifestyle on health.Iran J Public Health. 2015; 44(11): 1442-1444.

[159] Al-Nakeeb Y, Lyons M, Dodd LJ, Al-Nuaim A. An investigation into the lifestyle, health habits and risk factors of young adults. Int J Environ Res Public Health. 2015; 12(4):4380-4394.

[160] Healthy living: What is a healthy lifestyle? World Health Organization regional office for Europe, Copenhagen. 1999; http://www.kznhealth.gov.za/healthyliving.pdf Downloaded on 12.08.2019.

[161] Lifestyle and health, part I: Summary of input on the conversation on health. pp 01-41.https://www.health.gov.bc.ca/library/publications/year/2007/conversation_on_health/PartI/PartI_LifestyleHealth.pdf Downloaded on 17.08.2019.

[162] How lifestyle impacts your health. https://www.ashg.org/pdf/'How%20Lifestyle%20Impacts%20on%20Your%20Health'%20Brochure.pdf. Downloaded on 20.08.2019.

[163] Pattanayak S (2018) Thrown plastics – cause of an incoming global disaster. Explor Anim Med Res 2018; 8(2):133-139.

[164] Verma KC, Kushwaha AS. Demineralization of drinking water: is it prudent? Med J Armed Forces India 2014; 70(4): 377-379.

[165] Puro K, Sunjukta R. Samir S, Ghatak S, Shakuntala I, Sen A. Medicinal uses of Roselle plant (*Hibiscus sabdariffa* L.): a mini review. Indian J Hill Farming 27(1): 81-90.

Chapter XVI

Summary

In this volume of the book, steps for marketing of different succulent parts of plants at different health related purposes without addition of any synthetic chemical are discussed in detail with an intention to introduce some of such products in the market very shortly.

The fruits can be supplied to all the global consumers as fruit pulp, fruit juice or fruit ice cream in all seasons throughout the year and without adding any chemical preservative, synthetic color, flavor etc. The children and young people, who are not interested to eat fruits as such, will definitely be interested to take these products and these can be considered as the only type of amusement product and beverage which is non-toxic to our health in true sense. Twenty fruits are listed for that purpose. The details regarding their possible formulation, presentation, storage, transport, marketing and viability checking are discussed.

Formulation of some skin care and hair care products totally of plant origin is added in this book. These are to be made directly from the related parts of medicinal plants without adding any synthetic chemical and most of them are practically used by a section of people for many years. So, chance of toxicity from them is very less.

The succulent fruits, leaves, roots, stem, flowers etc. parts may be used as oral medicines for various important purposes like control/ cure/ potentiation of body efficacy for diabetes, high blood pressure, heart diseases, reduction of blood cholesterol, immune-stimulation, complications of Dengue fever, urinary tract disorders, cancers, asthma, pneumonia, bronchitis, insomnia, dementia, increase of memory power, osteoporosis, anaemia, excessive menstrual bleeding, restoration of sexual power, jaundice, kidney and liver protection, irritable bowel syndrome, stomach ulcer, dysentery and bloody enteritis, constipation, hemorrhoids and piles, eczema and other skin problems etc. Sixty-one plants with such reported efficacy are described in this book. A marketing-oriented study should be initiated now to validate the efficacy, to calculate the dose and to determine the toxicity level of these succulent bio-medicines.

In the contemporary systems, different chemicals of different categories are added with different foods and food products. These chemicals and their possible harmful effects on our health are discussed in brief. Alternative of chemical preservatives for the proposed bio-medicines and other bio-products, available as offers of some plants, insects and animals of nature are discussed for their effective use. The contemporary procedures and materials used for encapsulation and preservation of related products are also discussed for possible identification of effective one or getting idea for research to identify new procedures and materials for the proposed bio-products.

For selection of proper identifier of spoilage of the proposed products, the available tools are discussed. The Vaccine Vial Monitors are perhaps having the strongest probability to act as an identifier of spoilage of the frozen bio-products.

A model to perform detail research to prepare specific guidelines and treatment schedule for different diseases by use of succulent bio-medicines is also added at a tabular form.

Importance of different lifestyle factors to potentiate the efficacy of non-chemical medicines and also their role in continuation of healthy life are discussed. Some points related with selection of proper edible items for healthy life and preparation of healthy foods are added for their relevant effects.

Dr. Shibabrata Pattanayak, B.V.Sc. & A.H.; M.V.Sc. (Immunology); P.G.D.R.D.; F.M.D.I.T.; Ph. D. (Pharmacology) is working for development of one alternative healthcare system by excluding intake of any synthetic chemical and following of a designed lifestyle along with use of unaltered herbs directly as medicine. Use of extracts and cut pieces of parts of succulent medicinal plants for prevention and cure of diseases after their proper validation of efficacy is the main theme of his research.

Apart from the use as some curative medicines, direct succulent parts and extracts of herbs can be efficiently used for restoration of health and prevention from diseases, preparation of healthy amusement foods and drinks, preparation of non-toxic skin care and hair care products etc. The present volume of the book contains detail directions for production, packaging, storage and transportation up to the consumer's level of such products.

The first volume of the book (For treatment of infectious diseases) catches attraction of researchers of the globe and it is presently ranked above 99% of all publications added in Research Gate. Dr. Pattanayak presently ranked above 96% of the global researchers enlisted under Research Gate as per their calculation of Total Research Interest.

The present book is offered to all the researchers and entrepreneurs of the globe having an intention to alter the food and medication habit of the people dramatically to a cheaper, far more efficient and healthier alternative.